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HEREDITARY OCCURRENCE OF ENLARGED PARIETAL FORAMINA*

THEIR DIAGNOSTIC IMPORTANCE

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IT SEEMS desirable to draw attention to the following facts: that the parietal foramina may be markedly enlarged; that such enlargement is a congenital anomaly with hereditary transmission; and that such large foramina can during life be discovered by palpation or by roentgenography and may easily lead to serious errors in diagnosis.

Our interest in this matter was aroused by the presence of the anomaly in a patient in the medical ward of the Hospital of the University of Pennsylvania in February, 1935.

The patient, a white male, G. T. (1935–19139), aged fifty-one, was admitted because of a digestive disorder which may be dismissed with the statement that a duodenal ulcer was diagnosed and successfully treated by surgery.

During ward rounds, one of us (O. H. P. P.) examined the patient and discovered the presence of the cranial anomaly which is the subject of this report. As the hand was passed over the upper posterior aspect of the head, two defects in the skull were felt, each readily admitting the tip of a finger much as if one passed the hand around a bowling ball. The scalp overlay these openings and there was no visible or palpable depression or abnormality in the scalp or hair. The openings could be felt on very slight pressure; they were symmetrical one on each side of the midline.

The interest shown greatly amused the patient who interrupted our speculations as to the nature of the deformity by stating that the "holes" had been present all his life and that they were also present in other members of his family. Naturally we were led to investigate the matter further. Roentgenograms of the patient's skull (Figs. 1 and 2) confirmed the presence of a large rounded defect in each parietal bone. Roentgenograms revealed no evidence of increased intracranial pressure and no increase in the vascular markings near the openings; the pineal body was calcified. There were no defects in the other bones of the skull nor in any of the other bones of the skeleton.

Our Department of Radiology had no previous record of any such finding in spite of the unusually large number of skull examinations made in this Department. As usual, however, when the literature was searched, unexpectedly full information was found about the anomaly and a little also about its hereditary nature. No reference to the occurrence of this striking and misleading anomaly was, however, found in roentgenologic literature.

The parietal bone frequently exhibits near its upper posterior angle a minute

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FIG. 1. Large bilateral parietal foramina, the right being the larger. Anteroposterior view of G. T., male, aged fifty-one.

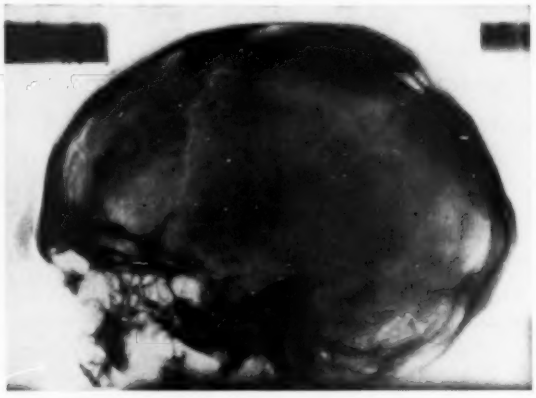

FIG. 2. Lateral view of same case as Figure 1. Note bevelling and central bridge.

pin-hole through which an emissary vein passes. This opening is named the parietal foramen. The foramen is very often wanting, and when visible may be closed. Sometimes it is double. Usually its size does not exceed a millimeter in diameter but anatomists have for many years recorded the fact that "in very rare cases it is a large hole, which may even admit a finger" (Piersol). Such large foramina have been the basis of a number of reports, the best and most complete of which is that by Greig[7] of Edinburgh published in 1927.

Greig in his article gives an extensive bibliography on this subject including references as old as that of Lancisi[9] in 1707. Nevertheless the number of skulls exhibiting this anomaly has always been small. Hyrtl,[8] in 1865, stated that no such specimen existed in any museum in Germany or France. In 1902, Piersol[15] described a specimen from an autopsy at the Philadelphia General Hospital and stated that only 13 skulls with conspicuous perforations had been described. In 1919, Pamperl[14] reviewed the records of 36 specimens but

FIG. 3. Photograph of skull from Indian burial mound, Palo Alto. (Courtesy of Dr. Ales Hrdlicka.)

FIG. 4. Another view of skull shown in Figure 3.

Greig states that Pamperl's list is not complete. The earlier literature merely mentioned the anomaly and it was not until 1866 that Turner[17] published the first adequate description of the condition on the basis of a skull which had also an abnormal opening in the occipital bone. Greig's extensive review includes a description of 2 skulls from the Museum of the Royal College of Surgeons of Edinburgh.

A search in Philadelphia through the large Morton Collection of skulls in the Academy of Natural Sciences, the Mutter Collection in the College of Physicians and that in the Wistar Institute failed to reveal any parietal foramen of more than 4 mm. in diameter. However, a visit to Dr. Ales Hrdlicka of the United States National Museum in Washington, D. C. was more successful for he was familiar with the anomaly and had one beautiful example of it in the Museum Collection (Figs. 3 and 4). We are indebted to Dr. Hrdlicka for these photographs. This skull (276981) was from a pre-white Indian burial mound in Palo Alto, California.

These pictures show clearly the large size and the position of the openings; one might almost think them the result of prehistoric surgery. One can also see that the edge of the holes is bevelled, with the defect less marked in the inner than in the outer table of the skull. This seems always to be the case. The defect seems to be simply an anomaly of development and not explainable upon any anomaly of the vascular system nor on disease or thinning of the bone although thinness of this area in the parietal bone is not uncommon and has been the subject of another excellent review by Greig.[6] In the development of the parietal bone, a final pin-point opening, the parietal foramen, is left open as ossification proceeds. Foramina of large size apparently result from an irregularity in the process of ossification.

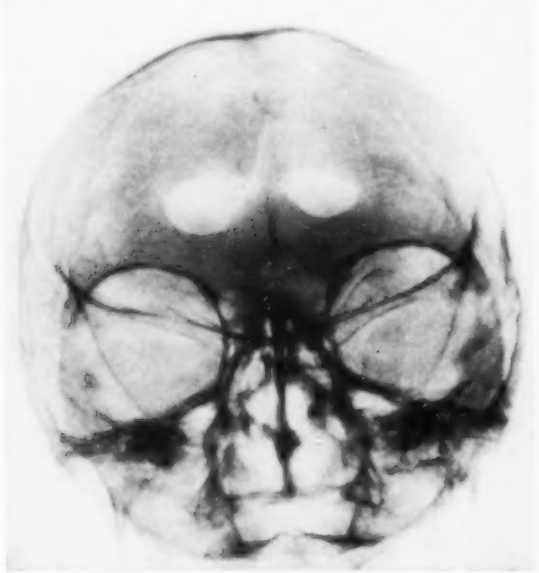

Fig. 5. Large parietal foramina. Anteroposterior view, mother of G. T.

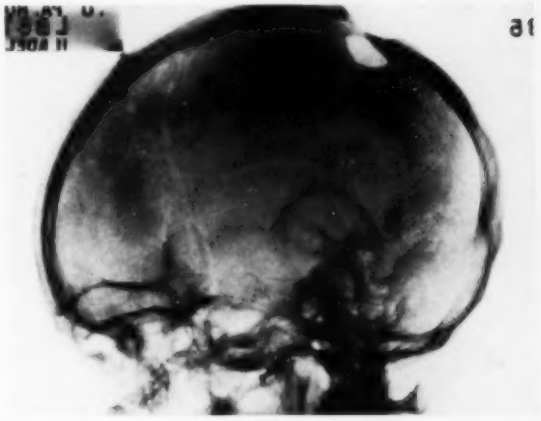

Fig. 6. Lateral view of same case as Figure 5.

The discovery of the anomaly during life has also been reported only a few times; first probably by Greig[4] in 1892. In 1919, Pamperl stated that it had been observed during life only 5 times. This is probably due, in part at least, to the fact that few if any symptoms are caused by the anomaly. In a few instances epilepsy has been blamed on the openings but as a rule the patients are in no way inconvenienced unless pressure or tension is put upon the scalp overlying the foramen. No report of meningocele through a parietal foramen has been found.

Recent reports include one by Armand-Delille, Scemmama and Deliencourt[1] who found the anomaly in a healthy eleven year

FIG. 7. Large parietal foramina. Anteroposterior view, son of G. T.

old girl, and one by Marie[13] in a thirteen year old child. Roentgenograms of this latter case present the usual appearance.

Having gained this much information, we felt we were justified in diagnosing the defects in our patient as due to anomalous enlargement of the parietal foramina or, as Pamperl terms it, "foramina parietalia permagna." The next question was raised by our patient's statement that other members of his family had the same anomaly.

FIG. 8. Lateral view of same case as Figure 7.

We were able to examine the patient's mother, his son, his sister and her four children. The patient's grandmother was dead but the family all were positive that they had frequently felt the "holes" in her

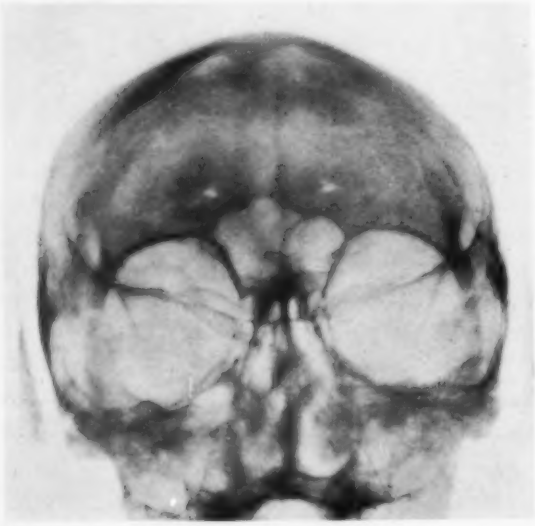

FIG. 9. Parietal foramina in G. T.'s sister, E. E.

FIG. 10. Parietal foramina in G. T.'s nephew, R. E.

head. Of the living family, the mother (Figs. 5 and 6) exhibited very large foramina, as did the son (Figs. 7 and 8). These were easily found by palpation. The patient's sister had bilateral foramina which ina of top normal size; the younger of normal size. The occurrence of the anomaly in this family, as far as we have been able to study it, is shown in Figure 11.

Again a search of the literature proves

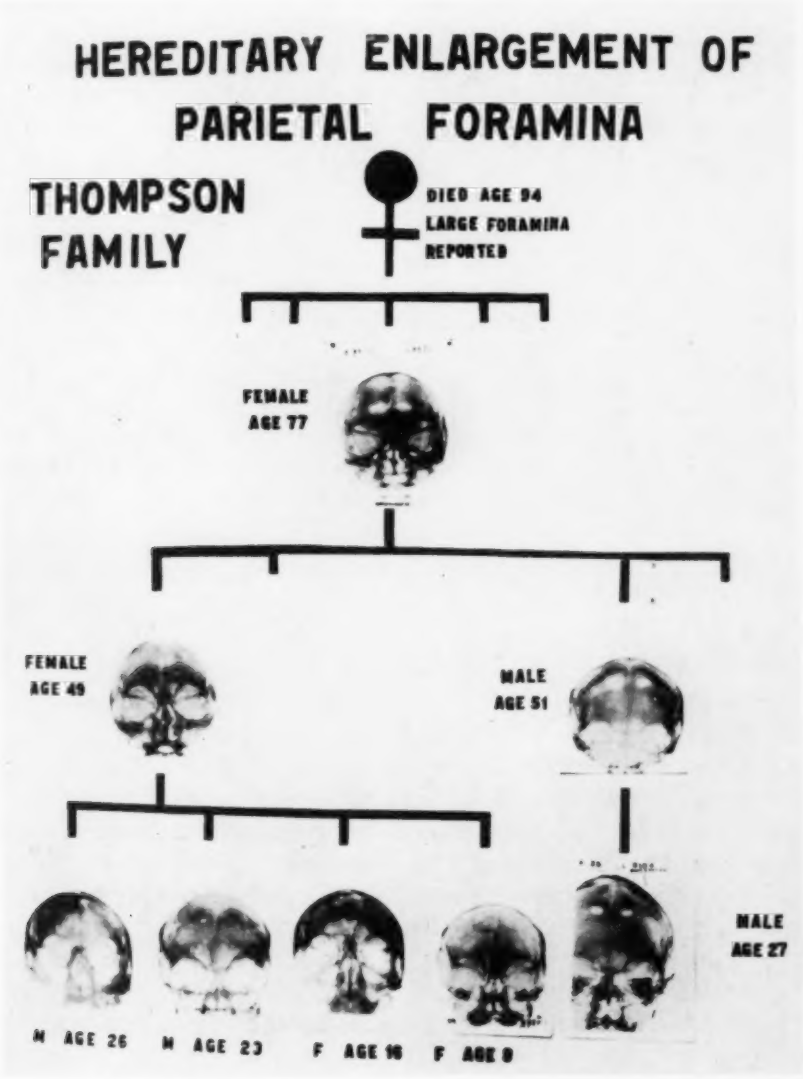

Fig. 11. Roentgenograms of enlarged parietal foramina in three generations.

while small were larger than normal (Fig. 9). This sister has four children—the oldest, a boy, has foramina similar to his mother's; the second child, a son, has openings measuring 7 mm. on the right and 3 mm. on the left (Fig. 10). Of the two younger girls the elder has bilateral foramour observations not unique for we have found the report of one similar family. Also in the older literature there are a few hints in this direction. Maciesza[11] reported 2 skulls with the anomaly among several skulls from the same grave. Symmers[16] in recording a skull mentioned that the father

of the individual was said to have had the same anomaly. Greig[4,5] reported the condidition in two brothers. Macklin[12] mentions the anomaly in her extensive list of hereditary lesions. Cohn[2] reported its presence in a mother and two identical twins.

Lelong and Bosquet[10] report the presence of this anomaly in a boy, aged five, and in his mother; the maternal grandfather was said by this family to have also had the defects. The roentgenograms of the child's skull reveal large foramina in every respect identical with those of our patient. As is the rule, the child exhibited no other anomaly of the skeleton and was normal and healthy.

The most important report, however, is that of Goldsmith[3] in 1922. This escaped general medical notice because it appeared in the *Journal of Heredity* and also because the report had as its main title "The Catlin Mark" from the name of the family exhibiting the defect. It is true that the secondary title was "The inheritance of an unusual opening in the parietal bones." Goldsmith had the opportunity to examine 56 members of the Catlin family distributed in five generations; 16 exhibited the anomaly. Of these 16, three were women and 13 were males although there were 29 women to 27 men in the total examined (Fig. 12). He does not state whether all of the examinations included roentgenograms although three roentgenograms are reproduced.

Goldsmith points out that the inheritance does not seem to fall in line with any of the usual laws of inheritance. He believes that the openings are larger in the young, that at first it is a single opening which is later divided by the ossification of a median bridge. He also believes that the defect may disappear as adult life is reached.

Some support for these opinions is supplied by our study of still another family exhibiting large foramina. The promptness with which this family came to light once we knew of the anomaly suggests that the condition is not uncommon. One of our roentgenological staff readily recognized the lesion in the films exhibited at a roentgenologic meeting. The defects shown in the skull films of a young girl were presented as possibly due to Hand-Schüller-Christian's disease, but to one who had once seen the picture of enlarged parietal foramina the diagnosis was obvious.

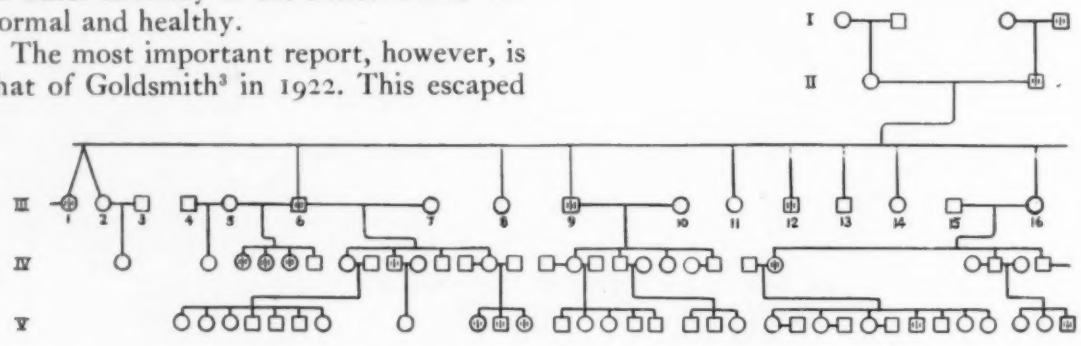

FIG. 12. Family tree of Catlin family showing incidence of enlarged parietal foramina. (Reproduced with permission from Goldsmith[17].)

We are indebted to Dr. J. W. Post for the opportunity to study this negro family. In addition to the girl we have been able to examine her mother, her sister, two aunts and three cousins. Also the family insist the child's grandfather (English Hopkin) has the same "holes." One aunt has demonstrable foramina but the other and the cousins are negative. The child's sister, only seven months of age, has a large central defect. The child herself, two years of age (Fig. 13), shows a large merged defect and also the not uncommon anomaly of the occipital bone called by some the "Inca bone."

This completes our own experience with

this condition and the gist of the data in the literature. Those who wish to go further will find access to the literature through the references given by Piersol[15] and by Greig.[7] Apparently the defect is an erratic hereditary anomaly of ossification, bearing no relation to any disease of the skeleton. There seems to be little support for the claims made by several writers that it results from increased intracranial pressure and is more apt to occur in those with small skulls.

Clinically, the anomaly is of only slight importance, although the defects might be found and misinterpreted. It seems to add nothing as yet to our knowledge of heredity nor does it help us understand the underlying error in the process of ossification. To the roentgenologist, however, a familiarity with the anomaly will prove helpful. It is not necessary to enumerate the cranial defects with which enlarged parietal foramina might be confused: Hand-Schüller-Christian's disease, syphilis, secondary neoplasm, trephine openings, dysostosis (cleidocranial) of the cranial bones, meningocele and osteoporosis circumscripta are some conditions which come to mind. It is the roentgenologist who will usually have the responsibility of making the differential diagnosis and who will have the opportunity of identifying such instances of anomalous parietal foramina as he may encounter.

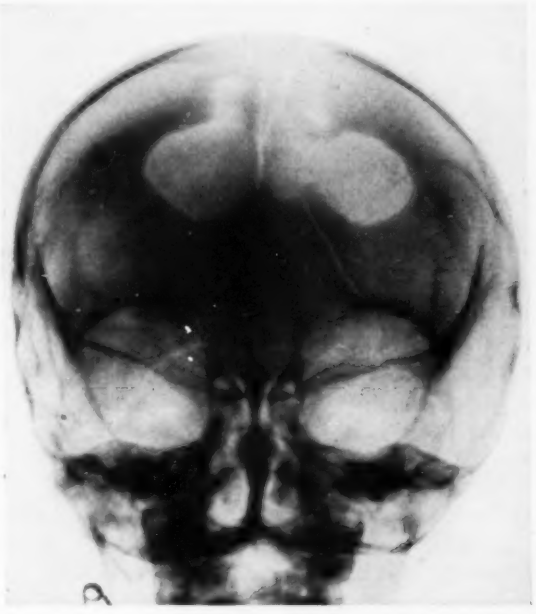

Fig. 13. Very large merged parietal foramina in child two years of age. Note also anomaly of occipital bone.

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DISCUSSION

DR. M. C. SOSMAN, Boston. This is a most interesting contribution by Dr. Pepper and it exemplifies the statement that discoveries are made only by the prepared mind or by accident. When I first read the details of this condition in Dr. Pepper's paper and saw copies of the films which Dr. Pendergrass sent me I stated that this was the first time I had ever seen this anomaly. Very shortly, however, I changed that to the first time I had ever recognized this anomaly, for I dimly remembered a patient with symmetrical defects in the parietal bones which I had classed as trephine holes for ventriculography, but there was no history of that having been done. The patient came from another State and was not very reliable, so that the matter was dropped, there being no tumor palpable. The defects were considered as an anomaly of no clinical importance or still possible trephine openings.

Aside from the interest in finding such a rare anomaly, and the conclusive demonstration that it is hereditary, the chief value in recognizing it is to avoid mistaken diagnoses such as xanthomatosis, metastases and traumatic defects. The absence of a palpable tumor and of local tenderness should be of decided help when in doubt.

Since receiving a copy of Dr. Pepper's paper, two of my students have found two cases in the Warren Museum at the Harvard Medical School. In one the skull cap was found in the anatomical dissecting room, and although attempts have been made to trace the family, none could be located for examination. In the other case the defects are symmetrical, are in the proper location and are of good size (3×5 cm. each), but there is still a thin shell of bone representing the inner table. This is so thin that it easily transmits the light from the lantern. Furthermore, just medial to the defect on the right can be seen a normal parietal foramen.

This second skull is from the Tello Collection of ancient Peruvian skulls also from our museum, and belongs to an age antedating any written history on this Continent. It shows asymmetrical defects with sharper edges, and is undoubtedly an example of the trephine openings made in those prehistoric days to let out the evil spirits. This skull also shows normal parietal foramina quite close to the midline.

Whether these defects are enlarged parietal foramina or not is unimportant. I am glad to know about them and I hope to recognize them in the future as you all will do, I am sure, probably avoiding a serious mistake in diagnosis.

DR. PEPPER (closing). In reply to Dr. Sosman's question as to whether these openings are surely parietal foramina, I may say that one never finds any normal parietal foramina in the skulls which show these large defects. Also the anatomists accept these defects as parietal foramina and their shape and position are in keeping with the way that the transverse fissure ossifies to leave normally a small parietal foramen at each end. If it does not close, it might be expected to leave an eye-shaped opening where these openings are found. The evidence is good that they are parietal foramina.

Whether they are related to the thinning of the parietal bone, which you will find at many autopsies, I do not know. We have already found several instances of this since we have been interested in these defects. Greig, the same man who reported on the skulls with enlarged parietal foramina from the Royal Museum in Edinburgh, has given an extensive report on symmetrical thinness of the parietal bones. He pictures and discusses skulls similar to the skull cap which Dr. Sosman has just exhibited I think the two are entirely different things. It may be they are two manifestations of the same disturbance of ossification but certainly the result is different. The picture will be different in the roentgenograms and there is no hint yet of heredity in the thinning as there is now proved in the large parietal foramina.

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OSTEOLYTIC LESIONS INVOLVING THE CALVARIUM

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INTRODUCTION

ARCHEOLOGICAL records have consistently ascribed fenestrated skulls to either of two general causes: the ravages of syphilis or the havoc of battle or surgical trauma. It is interesting to think in retrospect over those hundreds and even thousands of years to the times when man oppressed man by use of the club, the mace, the sling shot or the arrow. In those days it was the head that most frequently received the brunt of damage and, as a consequence, much primitive surgery was directed toward the relieving of increased intracranial pressure, especially in cases of depressed fractures. Perhaps this accounts for some of the ancient trephining, though many historians attribute the early development of this art to superstitions that fits or headaches ought to be relieved by producing an exit whereby "evil spirits" might leave the head. The fact remains that a considerable percentage of the holes in skulls, which commemorate those times, were actually produced by ancient surgeons. It is realized, too, that syphilis was a widespread offender. However, it is doubtful whether it should be blamed for so many patterns of cranial defects. Baudouin[2] cautioned European museum collectors in this matter; he believed that the luetic relationship to these conditions had been greatly exaggerated. Extensive studies of the relics of ancient civilization in the Americas convinced MacCurdy[34] that 17 per cent of his collection of 273 skulls showed evidence of actual trepanation. He accounted for some of the rounded and smoothed-off holes on the basis of infections superimposed upon battle traumas. He reported one case as a persistent fontanelle and another as an osteosarcoma. He was suspicious of syphilis in relatively few instances. Hrdlicka[19] and Moodie[36] have further expanded the terminology of palecpathological diagnoses, including mention of such conditions as "osteomas," "acromegaly," "soft tissue erosions," "osteoporotic tumor," "cribra cranii" and "hyperostosis cranii."

Exact understanding of the majority of lesions responsible for lytic areas in the skull, as they are encountered today, has come only in recent years; that is, since by the roentgen ray we have been able to distinctly visualize the processes in the living, and thereby allow a correlation between the mode of development and the tissue analysis. These correlations have greatly widened our scope of diagnoses. Indeed, an outline of all the various conditions which are now known to affect the skull would be too lengthy and too cumbersome to discuss in a single compilation of this sort. It has seemed pertinent therefore, to confine our considerations to that limited portion of the skull included in the term "calvarium." Even with this anatomical limitation the scope would still be involved, and attempts at a concise exposition would be hazardous should one aim to include the essentially bony productive lesions or even those conditions producing deossification of a more or less generalized sort. Therefore, this discussion will further exclude such conditions as osteomas; hyperostoses; osteosarcomas; osteitis deformans; the convolutional atrophies associated with craniostenosis or resultant from the more specific causes for increased intracranial pressure (infections, vascular abnormalities, tumors, etc., involving the brain substance or its surrounding meninges), or the generalized deossifications

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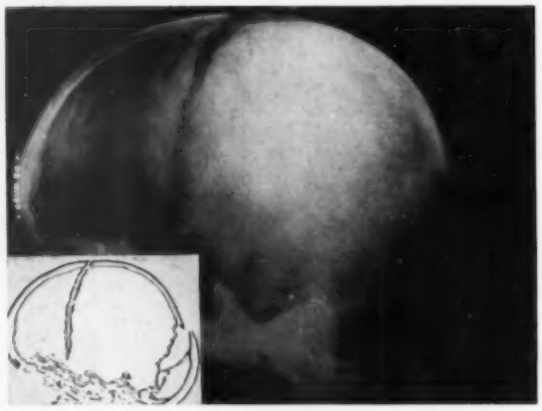

FIG. 1. Dysostosis of the Cranium. It was requested that this patient come in for roentgenography because of the findings in the case of his sister who had suffered a nonunion of a fracture of a femur for a period of three years. Her skull showed a dysostosis though it was not quite so extreme as demonstrated above. Thus, both the brother and the sister, who were the only children in the family, showed this dysostosis. Each had had repeated fractures of the long bones. Both were dwarfed though their parents were of normal stature. The limitation of growth in both these cases seemed to be confined to the skull and the bones of the extremities, the latter being of short stubby dimensions. The trunk measurements were proportionately long.

which might be associated with abnormalities of an endocrine nature, avitaminosis or hypervitaminosis D, blood dyscrasias or a systemic acid-balance. Even with these eliminations we are left with a group of conditions, frequent in occurrence and amply confusing in their manifestations—the more or less localized, or at least patchy osteolytic lesions involving the calvarium.

DEVELOPMENTAL DEFECTS

There are several common or anomalous developmental conditions which must first be considered and in all cases ruled out before otherwise attempting to classify an apparent destruction of one or both tables of the calvarium. Particularly to be mentioned are:

(1) Dysostosis of the cranial bones
(2) Meningocele
(3) Vascular pools
(4) Pacchionian depressions

Elongated defects, especially those which are located in the midline, should prompt the consideration of deficient union of the cranial bones. This condition may be found in association with an absence of, or defective development of, one or both clavicles—a so-called "cleidocranial dysostosis," or it may be a defect confined only to the skull, particularly in those having had a marked congenital hydrocephalus. Recognition of this condition should not be difficult since the openings are bounded by the suture borders of the frontal, parietal, occipital or wormian bones (Fig. 1).

Akin to this condition, though at times more difficult to recognize, is a partial dysostosis; a more localized gap in the

FIG. 2. Meningocele. This patient was thirteen months of age when studied. Two small "lumps" had been noted on the forehead soon after birth. These lumps were soft; they presented no discoloration; they usually appeared wrinkled and they practically disappeared when the child cried. Note the site of these lesions—the glabellar region; note also their resemblance to frontal sinuses in this projection, but this infant is too young for such development. The lateral view, of course, visualized the soft tissue protuberance which was conspicuous clinically.

union of the cranial bones. This is almost always the result of an interfering meningocele. Here, the opening may be round and even circumscribed by a border of contrastingly dense bone but its location is always distinctive—the midline, and particularly the lower frontal or the occipital region. A profile visualization might reveal a soft tissue protuberance (Fig. 2).

Areas of conspicuous vascular pools may be deceptive. LeWald,[32] and Whitlock[53] have emphasized the dangers of permitting rash surgery simply because of erroneous roentgenological opinions as to these markings. Venous pools are usually located in the diploic spaces and particularly in the anterior or posterior parietal regions. The outlines of these erosions are characteristically diffusely irregular. They are distinctive because of their relationship to two or more venous channels. Occasionally, the erosions may take place on the inner aspect of the internal table, due to pockets of the meningeal vessels or even of the venous sinuses. For recognition of these it is important that lateral stereoscopic studies be made (Fig. 3).

Pacchionian depressions are really a type

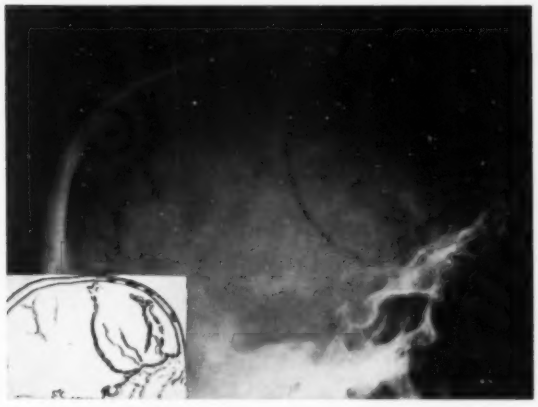

Fig. 3. Vascular Pools. Roentgenography was requested for this male, aged forty-eight, because of a fainting attack. The etiology of the fainting was finally determined to be of a cardiac nature; no pathology could be evidenced in the brain or the meninges. This film is reproduced to show what might readily be interpreted as tumor erosions, but, instead, can be seen to signify venous "pools" or "lakes." Note the relationship to the grooves of the diploic vessels.

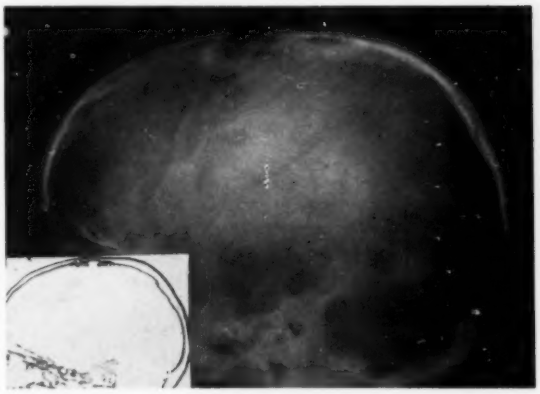

Fig. 4. Pacchionian Depressions. Note the parasagittal position of the depressions into the inner table. These are produced by erosions due to the Pacchionian bodies. Many of the bodies, particularly those more laterally located, have not produced erosions. There can also be noted a bulbous erosion in the occipital region in line with the groove formed by the lateral sinus. This doubtless represents a small dilatation of the sinus wall.

of this condition. They, of course, produce erosions of the internal aspect of the inner table. These are usually oval in outline and seldom exceed 2 cm. in either dimension. Though Pacchionian bodies may be found anatomically distributed over the entire cerebral hemispheres, roentgenographically erosions by them are usually confined to the parasagittal regions. Vascular connections are seldom visualized. Occasionally, calcifications may be noted beneath the erosions or at lower levels where other vascular nodulations of this sort exist. In this instance, the posteroanterior and anteroposterior views are especially important (Fig. 4).

Lesions Essentially Extra-Osseous

Secondly, one must consider the possibility of erosions by lesions essentially situated in the regional soft tissues, such as:

(1) Neoplasms of the scalp
(2) Pneumatocele
(3) Angioma of the meningeal vessels
(4) Dilated emissary vessels
(5) Aneurysm of the cerebral vessels
(6) Meningioma*

* Because of the most intimate relationship of these neoplasms to the bone and because their picture is so easily confused with that of lesions actually arising within the tables of the skull, this condition will be discussed with the last group.

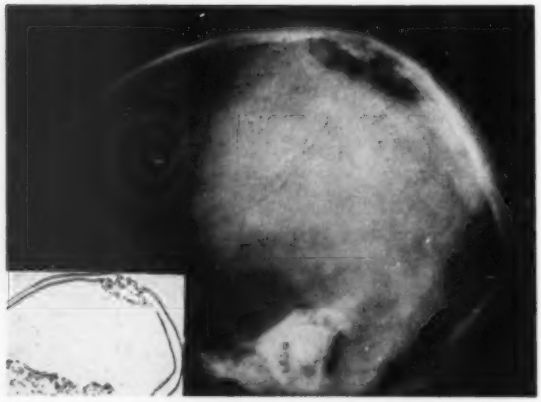

FIG. 5. Neoplasm of the Scalp. This male, aged forty-seven, had a scalp lesion on the vertex of the head for about nine years. For the past eight years it had been ulcerated and slowly enlarging. Biopsy, at the time of the above roentgenography, reported the neoplastic tissue as spino-cellular carcinoma, grade 1. There was an associated osteomyelitis.

(7) Cerebral neoplasm, superficially located
(8) Hydatid cyst in the cerebral cortex
(9) Porencephaly

Benign tumors of the scalp, such as sebaceous cysts, fibromas, and the like, would not be expected to produce erosions into the skull. Pressure effects by them are accommodated by relaxation of the superficial tissues. There is, however, a more progressive group of these lesions which occasionally invade the bone. Especially to be mentioned are the epitheliomata and the several varieties of sarcoma cutis[39] (Fig. 5).

Pockets of air, located either just beneath the scalp or even confined within the cranial vault, may produce circumscribed areas of increased radiotransparency, presenting the appearance of actual bone destruction. In these cases there may be the background of trauma, infection (perhaps superficial, with the production of gas by anaerobic culture, or the dissemination of bubbles because of the use of hydrogen peroxide, or deep-seated extensions—perforations through the wall of the paranasal or mastoid sinuses), or surgical procedure (such as encephalography or ventriculography).

Angiomas of the meningeal vessels are no doubt rare but they must be considered. They may produce patches of irregular erosion of the inner table, very similar to those produced by Pacchionian bodies. However, they would differ from the latter because of larger dimensions and usually a more lateral position. "Spider-like" varieties may produce elongated, tortuous channels of erosion or a widespread plexus erosion, as described under the term "angioma racemosum [18,29] (Fig. 6).

Occasionally dilated emissary vessels are found in the occipital region near the midline. These lie in a definite groove within the skull and subsequently penetrate both tables. Their appearance may simulate that seen in dermoid cysts (in cases where the latter have stalk extensions to the scalp) (Fig. 7).

Even more rare would be an erosion due to an aneurysm of the cerebral vessels.

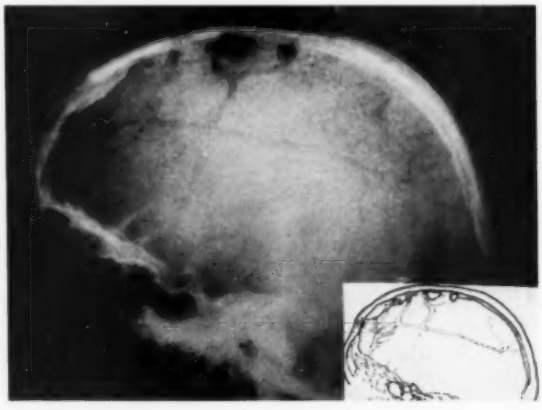

FIG. 6. Angioma of the Meningeal Vessels. This patient had suffered intermittently from headaches, nausea and vomiting, over a period of some fourteen years. These attacks were precipitated at times of excitement or mental strain. She had been studied thoroughly because of these symptoms. Several years previous to the time of this roentgenography, a cholystectomy and an appendectomy were performed—to no avail. This case is presented as an angioma because of the evidence of connections between the areas of conspicuous erosion and the venous channels. Note also the proximity of these erosions to the diploic channels. Serial roentgenography, performed at considerable intervals of time, showed no change in the condition.

Here the destruction is usually found in the basal portions of the skull or the occipital region.

In a similar manner, neoplasms may be responsible for localized erosions. If superficially located, they may produce a pressure erosion; if located immediately beneath the ventricle, they may cause deviation of the latter, thereby producing pulsation-erosions, as in the case of porencephaly. Tumors located deep within the brain substance are not included in this discussion because their manifestations on the calvarium are most likely to be generalized, without an excess of destruction in any single area. In any of these cases, there might be expected associated neurological manifestations, perhaps a shift of a calcified pineal body or signs of increased pressure as manifested by erosions about the sella turcica,[28,35] in addition to conspicuous convolutional atrophy and vessel markings (Fig. 8).

Hydatid cysts are rarities, though several reports of them have occurred in the literature.[7,26,49] Suspicions of such cysts should be substantiated by the habits of the patient as to eating uncooked or insufficiently cooked meats; perhaps the finding of definite cysts in the liver or even in the lungs, and the characteristic eosinophilia.

Fig. 7. Emissary Vessels. This illustration shows an occipital emissary vessel. Compare this appearance with that in Figure 21.

Fig. 8. Cerebral Neoplasm. The patient, aged forty-five, came into the hospital because of headaches and post-prandial vomiting. Her headaches were described as dull and throbbing, with intermittent seizures of sharp lancinating aches. These pains had progressed in severity during a period of about five months. They were particularly severe on the right side, radiating, seemingly, into the eye and down the right side of the neck. Occasionally, she noted violent tremblings but there were no localizing epileptiform seizures. Physical findings included signs of consolidation in the right chest and enlargement of the liver. Films of the chest visualized a lesion in the apex of the right lung. The patient died within a few days. Necropsy revealed a carcinoma, apparently primary in the lung, with metastases to the liver and brain. One of these had eroded through the dura and was adherent to the skull. It was located in the region of increased radiotransparency, shown above.

Birth injuries, or trauma subsequently incurred, may produce superficial atrophy of the brain substance, allowing a relative herniation of regional portions of a lateral ventricle. Such a condition, called a "porencephaly," by virtue of the ventricular pulsations, may be responsible for localized erosions. This situation may be definitely revealed by encephalography or ventriculography—whereby the ventricle or a portion of it may be shown to be either deviated or extended so as to lie in close proximity to the site of the erosion (Fig. 9).

FIG. 9. Porencephaly. This patient was nineteen at the time this roentgenogram was taken. His mother stated that his delivery had been prolonged and difficult. It was thought that he had suffered a birth injury; post-natal twitchings had been noted for several days. However, his development had presented no concern until the recent four years, during which time he had frequently manifested epileptic seizures. These were preceded by the sensation of dizziness and the seeing of "black spots" before his eyes. He completely lost consciousness, would stiffen for a few minutes and frequently bit his tongue. Of late, these attacks were occurring about every four or five days. Eye grounds revealed a homonymous hemianopsia. Encephalography showed that the right lateral ventricle was deviated several centimeters posteriorly, in contrast to its expected normal position and to the position of the left. The genu showed very close proximity to the area of erosion shown above. In addition, there was an unusual collection of air in the posterior fossa, just above the tentorium—a further suggestion of cortical atrophy in this region.

LESIONS LOCATED IN THE CALVARIUM

Finally, having arrived at the decision that the bone destruction is due to a lesion actually present between or within the tables of the calvarium, there are to be considered:

(1) Traumatic or surgical fenestrations
(2) Metastatic lesions
(3) Plasma cell myelomata
(4) Endothelial myelomata
(5) Chloroma
(6) Xanthomatosis
(7) Cholesteatoma ("epidermoid" or "dermoid")
(8) Hodgkin's granuloma
(9) Osteomyelitis
  (a) Nonspecific
  (b) Syphilitic (destructive phases)
  (c) Yaws
  (d) Tuberculous
  (e) Mycotic
  (f) Kala-azar
(10) Mucocele
(11) Osteoporosis circumscripta
(12) Meningioma

It should not be necessary to dwell upon those cases having an immediate background of trauma or surgery. Such information is usually conspicuously at hand and the picture is striking. However, remote injuries of this sort may not be so clearcut. For instance, trauma incurred during early life oftentimes causes resorptions either at the site of actual fracture, or perhaps even without fracture, as a result of impaired vascular supply. Osteoplastic flaps, after surgical explorations, may likewise manifest resorptions (Figs. 10, 11 and 12).

FIG. 10. The Effects of Recent Trauma. This film is included to present the appearance of recent trepanation. The patient had received a depressed type of fracture. Surgical clearance had been deemed necessary. That was done only about a week previous to the time of the roentgenogram shown.

Most of the truly destructive areas occurring in the calvarium are due to metastases. Here the age group is very important, for these lesions are seldom found under the age of thirty-five. They are usually multiple, and, though conspicuous, their borders are characteristically irregular and oftentimes diffuse—there being little tendency toward peripheral osseous reaction. The lesions can be found to be situated chiefly in the diploë but either table may be expanded. These findings should prompt the search for the site of the primary lesion. In females the breast is most often accountable.[37] Geschickter and Copeland[17] cite an incidence of bone metastasis in 5.2 per cent of 1,914 cases of carcinoma of the breast. The skull ranked fourth among the sites of skeletal involvement. The adeno- or comedo- varieties were found to produce essentially the osteoclastic type of lesion, while the scirrhous form frequently caused some osteoblastic reaction. In the male, the prostate is a likely site of the primary lesion.[6] Here the metastatic lesions are characteristically

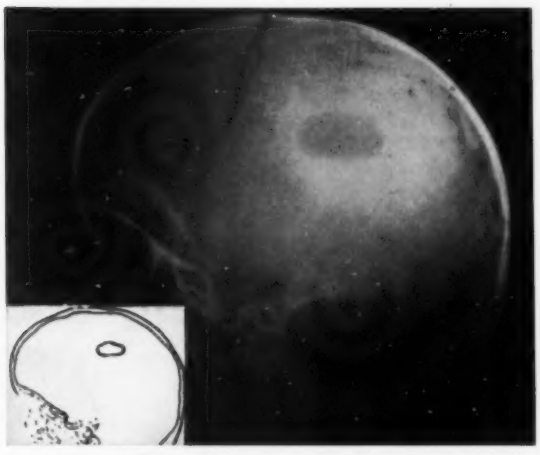

Fig. 11. Resorption Due to Trauma. This child was twenty-eight months of age when the above film was made. At the age of five months she had fallen from her crib, for a distance of several feet, landing upon her head. A hematoma developed, from which 10 c.c. of blood was aspirated. It was subsequently noted that there was a depressed area in this region. Besides the resorption of bone demonstrated, stereoscopic and tangential studies revealed a definite depression.

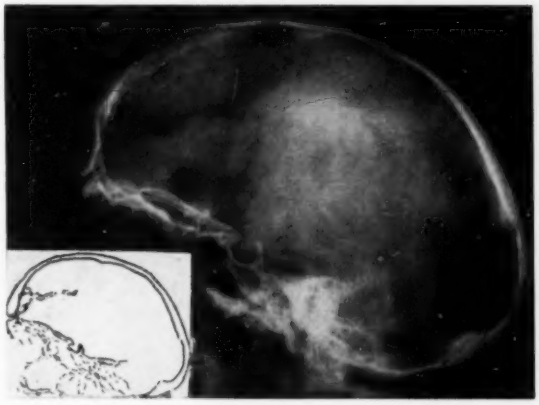

Fig. 12. Manifestations of Trauma Incurred during Childhood. This patient was studied at the age of nineteen years because of some loss of speech. At the age of two and a half, he had sustained a severe fall with a skull fracture. Note the absorption which has taken place in the fracture region. There had been no surgery associated.

diffuse and usually show some increase in density. Though hypernephroma is relatively less common than either of these, bone metastasis from it is of high incidence and therefore the kidney and adrenals should attract at least secondary interest among either males or females. This type of metastasis is almost entirely destructive. Other sites from which metastases have been reported to have occurred include the female genital tract, the thyroid, the gastrointestinal tract and the lungs[22,23] (Figs. 13 and 14).

Another condition which belongs to the same age group is plasma cell myeloma (multiple myeloma). It has generally been believed to be rare—as infrequent as 0.03 per cent of all types of malignancy, or about 3 per cent of the sarcomas found in bone.[17] Recent studies (where roentgenographic observations were made early in the course of this condition) indicate that a solitary lesion probably precedes the more or less generalized bone involvements by at least several months or even years.[41] The calvarium is usually eventually involved. The pathology concerned is of the nature of a neoplasm of the myelogenous tissue and for that reason the lesions are essentially located in the diploë. They contain the

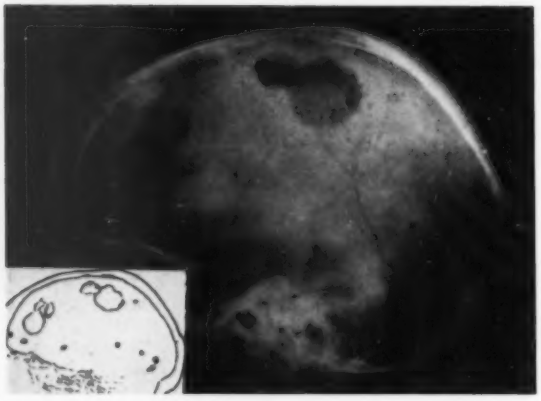

FIG. 13. Embolic Type of Metastasis. This woman, aged sixty, complained of recent development of "lumps" on her head. She stated that they had first appeared about six weeks previously, and that they had almost completely disappeared about one week before coming in, but they had returned to full size again. Two years before this, she had had a mastectomy. Histologically, the breast tissue showed an adenocarcinoma.

fluid and cellular elements of the blood (with a conspicuous content of plasma cells) and because of their intimate relationship to vessels they are oftentimes pulsile. By virtue of this latter characteristic they produce expansile outlines with undermined edges. Perhaps because of hemorrhages and the resolutions of such, they have been noted to recede intermittently in size, even to almost complete clinical disappearance. Pathological fractures in other parts of the skeleton, particularly in the ribs or long bones, are frequent. All of these are late manifestations; it must be emphasized that this is a more or less systemic condition which develops insidiously cover a period of years,[3] there being a background of periodic attacks of severe "rheumatic" pains—with episodes as to the attacks, these being progressive in degree, until the startling more or less sudden explosion of generalized skeletal debility, fractures and death (Fig. 15).

Involvement of the calvarium by endothelial myeloma is usually considered to be a secondary extension or metastasis from an original lesion elsewhere. Ewing[13] emphasizes the frequency of findings of early lesions in the pelvic bones and also in the femur or tibia. Suspicions as to this type of lesion, then, should stimulate studies of these parts of the skeleton. The earliest attack by the process seems to be in the shafts (rather than the metaphyseal extremities as favored by osteogenic sarcomas). Children and young adults are most frequently the victims; the finding is relatively rare after the age of thirty. The pathology concerned is believed to be primarily of endothelial elements, though some pathologists still believe the essential cell is an osteoclast. At any rate, in the long bones, where the manifestations are most diagnostic, the neoplastic elements have been found, pathologically, to extend into the Haversian and Volkmann systems, producing essentially destruction. The periosteum is stimulated to reaction and parallel striations of new bone are laid down. There is progressive lysis in the medullary regions and as the periosteal layers attempt to compensate there may be visualized an apparent widening and expansion of the cortices. Pathological fractures are not common. In the skull, probably because it is involved relatively late in the condition, these lesions are conspicuously destructive. Here, the involved areas are usually diffusely outlined, with little tendency toward

FIG. 14. Infiltrative Type of Metastasis. This illustration is included simply to contrast the appearance of an infiltrative metastasis. The patient was a woman of sixty-six, who had an extensive carcinoma of the breast with axillary extension. She developed soft tissue masses on her head several years after she had noted "the lump in the breast."

osseous reaction. Both tables may be eroded and expansion may be evident. Clinically the condition appears as a toxemia, with intermittent attacks of fever and bone pains. There may be localized redness and swelling over the particular bones involved so that osteomyelitis may be suspected. Most of the individuals affected have been of the frail, deossified, anemic type (Fig. 16).

Chloromas are likewise believed to signify neoplastic activity of myelogenous elements,[52] though some investigators still believe that they may arise from lymphoid structures. Most of the cases have been reported in children but the condition has been studied at all ages, from ten months to fifty-two years. The tumor is so named because of its greenish-yellow color. Askanazy[1] believed it to be a leukosarcoma* "derived from the formative cell of pus." It may develop in any bone where white cells are formed but it is most commonly found in the skull or long bones. The clinical course is one of progressive anemia with a rapidly fatal termination (Fig. 17).

Distinctly punched-out lesions, closely

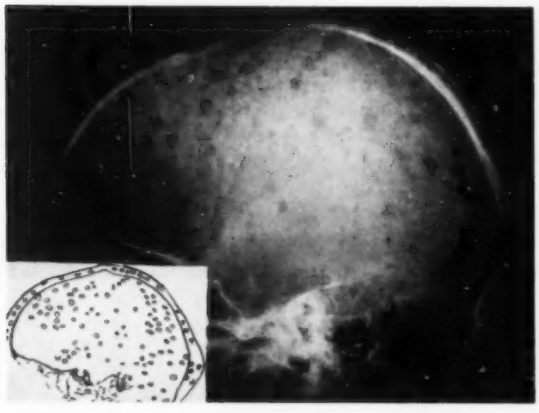

Fig. 15. Plasma Cell Myeloma. This condition was found in a female, aged forty-nine. Fifteen months previous to the time of this roentgenography, the patient had noted a sciatic type of pain over the right lower extremity, and a swelling in the right lumbar region. This swelling receded at times though it never completely disappeared. She was first studied about seven months after this development. At that time there was revealed a destructive lesion in the body of the 4th lumbar vertebra. Only half of the body was destroyed; the regions of the discs were intact but they were collapsed and the border of the left half of the vertebra was sharp and rounded. There was no osseous reaction; it was clearly a rapidly lytic process and one which manifested the effects of pulsations. This patient developed a paralysis of the lower extremities, and still later multiple fractures involving a femur and a humerus. The urine was negative for Bence-Jones protein but it contained large amounts of albumin. Biopsy of the skull lesions confirmed the diagnosis of plasma cell myeloma.

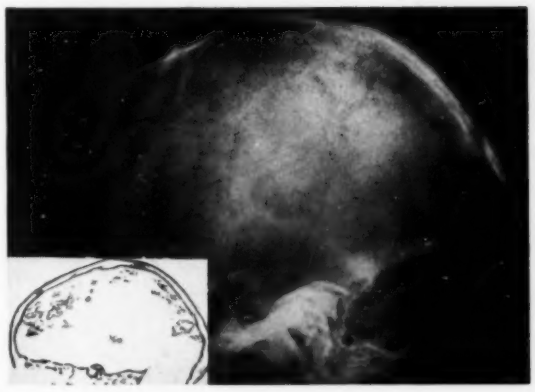

Fig. 16. Endothelial Myeloma. The initial complaint in this case was of aching in the left thigh. The patient, a male, aged twenty-one, noted swelling of the inner aspect of the thigh, but at first attributed this to an all-night ordeal of waiting on table. The pain, which was noted especially at night, persisted and progressed in severity, as did the swelling. At first, the roentgen appearance of the femur suggested a periostitis. Roentgen therapy alleviated the pain. After a few months, however, there was a recurrence, and by that time there were definite layers of periosteal proliferations and some perpendicular striations extending from the cortex. The inner portions of the cortex showed a few areas of erosion. The patient was carried along with repeated courses of roentgen therapy and serum therapy. About a year after these pains started he noted a vague aching in the occipitoparietal region. This increased in severity until it became almost constant for periods of three or four days, characteristically developing to a maximum intensity and then gradually waning in degree, to almost complete absence for as long as a week. He later developed similar pains in other parts of his body. Fearing his condition he committed suicide. Post-mortem studies established the diagnosis of plasma cell myeloma, involving the skull and many of the other bones.

* Craig[8] reported a very similar manifestation in a case where the pathological study revealed a "hemangio-endothelioma."

FIG. 17. Chloroma. This condition was found in a boy, aged four and a half. His mother described him as having been a sickly baby, very slow in development. For the past month she had noted "a lump forming over his forehead." This grew rapidly, reaching the dimensions of about 12 cm. in diameter within this short time. The red cell count was normal; the hemoglobin varied from 68 to 80 per cent; the leukocytes from 27,000 to 45,000, with as high as 89 per cent polymorphonuclears or transitionals. There were a few myelocytes. Biopsy showed the condition to be a chloroma.

FIG. 18. Xanthomatosis. The history in this case indicated normal development until about the age of two and a half. Her parents then noted "very sore gums." Two teeth were extracted. Subsequently, there continued a persistent foul smelling discharge. Roentgenography, somewhat later, revealed a large area of dissolution in the maxilla, which at the time was thought to signify the effects of infection and trauma incident to the extractions. The lesion finally healed but, due to extension of the achings, it was found necessary to remove the rest of the teeth. The next disturbance developed several months later—a polydipsia. Her father claimed she drank as much as 24 quarts of water in 24 hours, and that she voided large quantities of colorless urine. About the age of three and a half she developed a "lump" on the left temporal region. The parents were told it was a "blood cyst," due to injury. It was incised and curetted on two occasions, but refused to heal.

At the age of five, when a roentgenogram of the skull, shown above, was taken, it was noticed that the patient seemed alert mentally, but stunted in physical development. The head appeared round (because of the edentulous state), but the chest was poorly developed, the abdomen was very flaccid and protuberant, and the extremities were "spindly." Laboratory analyses showed serum calcium and inorganic phosphorus values in the upper limits of normal; cholesterol, varying from 187 to 243 mg. per 100 c.c. The urine showed a specific gravity of 1.002 with practically no evidence of concentration. There was a varying degree of anemia: red blood cells as low as 2,700,000, with the hemoglobin as low as 41 per cent. There was some anisocytosis. The white cells numbered as high as 18,000, though differential counts were not remarkable. Roentgenograms revealed sharply outlined, punched-out appearing lesions in the skull, the maxilla and both ilia. Soft tissue masses developed in the thighs. These were incised and drained. Cultures were negative and the tracts were obstinate in healing. Biopsy of the lesions in the pelvis and also in the skull revealed "adipose tissue" with numerous large "mononuclear mye-

resembling those seen in the myelomas, may be found in cases of xanthomatosis. It is a moot question as to whether this condition also represents a neoplasm, or the effects of minor infections, trauma, or endocrine disturbances. However, it is generally accepted that it constitutes a derangement in lipoid metabolism. There is believed to be an excess of circulating lipoids which produce a stimulation of the reticulo-endothelial cells; histiocytes are thereby produced in the attempts toward elimination. These cells become laden with engulfed lipoid but they are unable to carry it away. Production continues and therefore accumulation results. Reticulo-endothelial cells are found in various tissues but particularly in the lungs, liver, lymph nodes, bone marrow and spleen. Rowland[42] has emphasized that since xanthomatosis is generalized there might be expected diffuse reactions in all these sites, but in addition, there is the tendency to the formation of hyperplastic nodulations in the areolar tissues of the dura, the periosteum, the pleura and the peri-

FIG. 19. Cholesteatoma, with External Protrusion. A female, aged twenty, presented the complaints of boring headaches associated with a gradually enlarging, doughy "lump" on the side of her head. This had been noticed in its development for the past six years. Her mother remarked that several years ago, while combing her daughter's hair, she had examined the "lump" and found that the scalp moved over it, and that at that time it was bony hard in consistency. The lump itself did not move. Its size had reached about 6 cm. in diameter when her physician attempted to remove it as a "sebaceous cyst." When he found the depth of involvement he closed the wound. Subsequent exploration accomplished a complete shelling-out of the tumor. It was found to be well encapsulated and to extend into but not through the inner table. The outer table was destroyed. Histological study showed the characteristic epithelial capsule enclosing lamellated desquamations—characteristic of cholesteatoma.

toneum. The calvarium is frequently involved by erosions first through the inner table, these then perforating the outer table and even producing soft tissue tumescences.[33,43,48] However, the erosions may take place primarily through the outer table. Elsewhere in the skeleton the nodulations usually develop subperiosteally and erode through the cortex—a distinctive feature. In advanced stages, due to the diffuse reactions, varied effects may be noted. The most characteristic of these include exophthalmos, diabetes insipidus and

loid" cells (foam cells), polymorphonuclears, lymphoid cells and plasma cells. One pathologist remarked that many of the large mononuclear cells contained "circular bodies" which appeared as "yeast cells"; subsequent cultures for such were negative.

FIG. 20. Cholesteatoma, with Intracranial Protrusion. This patient was fifty-two when she finally sought medical help because of progressively failing vision of her right eye, occipital headaches, and nervousness. She had noted a blurring of vision, on the right, about twelve years previously. Since that time the eye had become almost completely blind; of late, merely being able to distinguish objects if at close range and with the use of glasses. Her headaches were aggravated by pressure applied to the back of her head, or by sudden turning of the head; at times, they were throbbing in character. For some time she had noted a "soft tumor" mass in the occipital region. Occasionally she had vomiting spells or periods of drowsiness, lethargy or depressed mental states. In addition to the cranial defect, shown above, roentgenography revealed evidence of increased intracranial pressure, as indicated by enlargement of the pituitary fossa and atrophy of the dorsum sellae. Perimetric fields showed a bilateral nasal quadrant, diminution in the visual fields and examination of the eye grounds showed a beginning secondary optic atrophy. At operation, the tumor was found to be cyst-like. It had destroyed both tables and it extended well into the cranial vault. Microscopical studies confirmed the features of cholesteatoma. This case is added to emphasize the possibility of invasion of the vault by these tumors. Here, the epithelial rest had doubtless been located either subdurally or within the substance of the inner table.

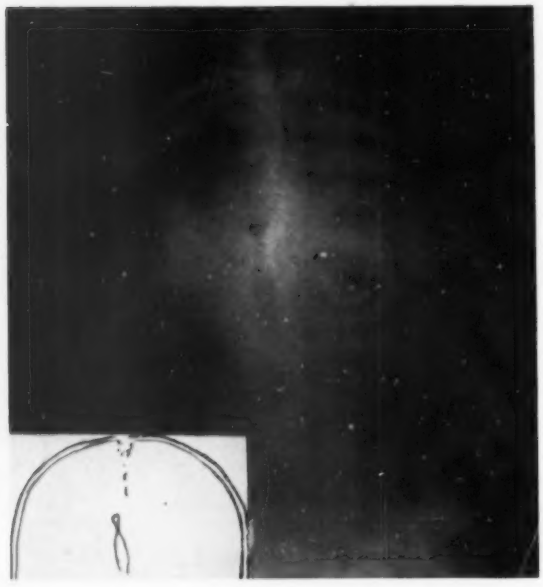

FIG. 21. Dermoid Cyst. Since their embryological development is similar it is not surprising to find that "dermoids" may resemble very closely the appearance of "epidermoids" when involving the bony portions of the skull. Necropsy in the above case demonstrated a "large cystic tumor measuring about 5 cm. in diameter; this was situated between the cerebellar hemispheres. The main mass had a pedicle which extended through a perforation in the occipital bone, becoming continuous with the scalp." The groove through the occiput coincided with the outline visualized roentgenographically, as shown above. Histologically, both the stalk and the body of the cyst were found to be lined with stratified epithelium, and the deeper layers contained follicles and sebaceous glands.

Clinically, the patient had been well until about nine months previous to her hospital entry. She was nineteen when she suddenly developed blindness, ataxia, occipital headaches and projectile vomiting. She appeared to have been an intelligent girl but at the time of examination she showed a definite impairment of memory; her gait was unsteady; she had a bilateral Romberg, was unable to coordinate in the pointing tests and presented a lateral nystagmus. Eye ground examination revealed an optic atrophy with choking of 6 diopters. The spinal fluid pressure was elevated to 640 mm. in the horizontal position. Besides the outline of the pedicle groove, shown above, roentgenograms revealed erosion of the dorsum sellae and expansion of the sellar chamber to almost complete encroachment upon the sphenoid sinus. She died of a cerebellar crisis before operation. Compare this appearance with that seen in the cases of emissary vessels (Fig. 7). In that case there were no localizing signs of evidence of increased intracranial pressure.

punched-out lesions in the skull. The lungs frequently show a marked increase in the pulmonary markings and a generalized dissemination of xanthomatous lesions may be found on the skin (Fig. 18).

Cholesteatomas are relatively rare causes for clearcut lesions in the calvarium. They are usually single and represent growth of embryonically misplaced epidermal cells. Brock and Klenke[5] object to the term "cholesteatoma," saying that it is descriptive only of the chemical by-products; to emphasize the nature of the origin of this tumor they would favor the term "epidermoid." Bostroem[4] distinguished "epidermoids" from "dermoids" as to their beginnings embryonically, and therefore the characteristic sites for their respective occurrences. Dermoids represent misplacement of ectodermal cells, occurring about the third to the fifth fetal week; in the region of the head, they are therefore usually found within the brain substance. Epidermoids represent misplacements occurring later, after the neural groove has closed; they are therefore usually found in the meninges, in the diploic spaces of the calvarium, or in the superficial tissues. Growth activity of these cells characteristically occurs about the age of puberty, or later. Depending upon their location, they may erode the inner aspect of the inner table; either, or both tables, if located in the diploë, or they may simply enlarge in the tissues beneath the scalp, presenting the appearance of an ordinary sebaceous cyst. When these tumors are encountered surgically they appear as sebaceous cysts, presenting a firm pearly encapsulation and containing foul smelling, soapy, flaky or crumbly débris. Structurally epidermoids consist of an epithelial coating, encysting lamellated desquamations with intermeshed cholesterin and lecithin. Dermoids differ in that they may, in addition, include sebaceous glands and follicles (Figs. 19, 20 and 21).

Another condition which may produce metastatic-like lesions in the calvarium is Hodgkin's granuloma. This type of bone

involvement is probably much more frequent than has generally been realized. These patients are usually treated symptomatically, or along specific lines, because of superficial evidence of the disease, or conspicuous findings in the chest or abdomen. They are carried along over a more or less protracted course of varied complaints; dull aching pains have too infrequently been investigated by skeletal studies. The incidence of bone lesions is therefore unknown, though Carver and Copeland[9] found record of skeletal involvement in 15 per cent of their 396 cases. The processes are essentially osteolytic, though osteoblastic reaction is a common concomitant. Lymphosarcoma is probably not so prone to invade bone but it may show similar lesions. The leukemias, though frequently resembling Hodgkin's granuloma clinically, usually produce a more generalized destruction when involving bone, particularly in the case of the skull (Fig. 22).

Infectious processes are not uncommon in the calvarium. They vary in their manifestations, depending upon the type of the invading organisms. Though rare varieties of infections have been reported, such as yaws, mycoses or kala-azar,[20] most of the cases in this general category fall in the realm of nonspecific osteomyelitis, syphilis, or tuberculosis.

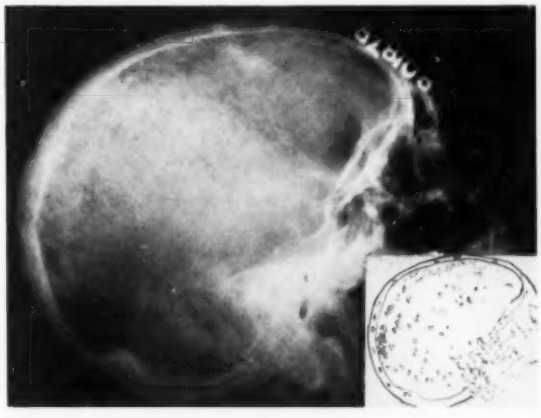

Fig. 22. Hodgkin's Granuloma. The manifestations in this skull represent a relatively late development in the case. The patient was a forty-three-year-old negro whose complaints at the time of entry included dizziness, generalized achings, swellings in the left axilla, and dyspnea upon exertion. He had lost 15 pounds in four months, He died within a few days. Necropsy revealed definite invasion by Hodgkin's granuloma in the skull, humerus, many of the vertebral bodies, the lungs, kidneys, brain and axillary nodes. (Courtesy of Dr. Herman Ostrum.)

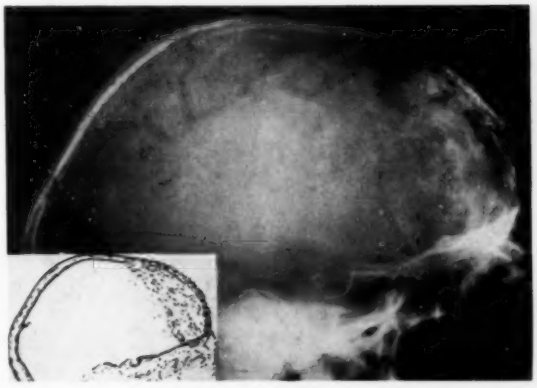

Fig. 23. Osteomyelitis, Nonspecific. This patient, aged seventeen, first noticed pain in the frontal regions only about a month previous to the time of the above roentgenogram. He had suddenly developed a "cold" and within a few days became very toxic. Involvement of the frontal sinuses was early revealed. The leukocyte count reached 28,000, with 84 per cent neutrophiles. The infection resisted various attempts at treatment and it became necessary to perform a craniectomy. Considerable purulent exudate was released from the diploic space.

Nonspecific varieties may represent: (1) extension of a process from a nearby infected paranasal sinus or mastoid cell, (2) hematogenous localization, or (3) actual implantation of the organisms by way of lacerations or surgical procedures on the scalp. The frontal, temporal or parietal regions are therefore the most likely locations. Fleming[14] observed that the spread of these infections is usually upward, along the diploic channels. Both tables may become eroded though there is the tendency toward greater destruction of the outer table. Invasion of the scalp tissues is a frequent occurrence but erosion through the dura is rare. Occasionally pockets may form beneath the dura, perhaps producing neurological symptoms; these pockets may be connected through the tables with similar

FIG. 23A. Osteomyelitis, Nonspecific, Embolic Type. A hemorrhoidectomy had been performed on this patient, aged twenty-three, about three weeks before the onset of acute boring pains in his left temporal region and seemingly in his left ear. Preliminary studies were directed to the ear itself and then to the left mastoid but definite pathology could not be found. After a week there developed swelling in the temporal region and a stiffness of the mandible. This patient, a soldier, was able to continue "on maneuvers" for almost three weeks after which time he was sent into the hospital and roentgen therapy was requested as treatment for a temporal abscess. He showed a leukocytosis of 15,000 with a neutrophilic count of 86 per cent, though his temperature, pulse and respirations were by this time normal. The swelling distinctly outlined the temporalis, though there was some superficial edema over the face and about the left eye. Roentgenography of the skull revealed the fenestration shown above (note its relationship to the vessel markings). A small dose of roentgen radiation was given to this area (200 r, using 140 kv. (peak) with filtration of 0.25 mm. Cu and 1.0 mm. Al). Within a few hours of the time of this treatment the swelling increased markedly, almost closing the left eye, and the pain became so severe that morphine had to be given. Two additional treatments were given, at two-day intervals, using half the dosage, and following each of these there developed the same local reactions. The temperature rise did not exceed 99.8°F. After ten days from the time of the first radiation treatment a central pitting developed in the tumor mass and that region was incised. A pocket of pus was encountered after penetrating the temporalis fascia and about 60 c.c. of thick creamy autolyzed material was released. Culture showed *Staphylococcus aureus*. Drainage continued for about a month. Roentgenographic studies showed a filling in of the lytic area after an interval of six months.

collections beneath the scalp, thus forming so-called "collar-button abscesses." Destruction of bone is relatively rapid so that necrosis and sequestration may be seen. In later stages regenerations may be evident in the form of eburnations and involucra formations. General constitutional reactions are commonly insignificant even though considerable extension of the processes may be evident (Figs. 23 and 23A).

Syphilis is usually given consideration in bone lesions but the actual incidence of bone involvement during syphilitic infections is unknown—this being true, again, because of the usual focusing of attention to treatment, once this condition is diagnosed. Roentgenography is seldom applied when boring bone pains are complained of by the luetic. From his clinical experience, Stokes[46] believes "that few syphilitic patients manage to escape some degree of reaction in this group of structures (namely, the osseous system) at some time in the course of their infection." Where roent-

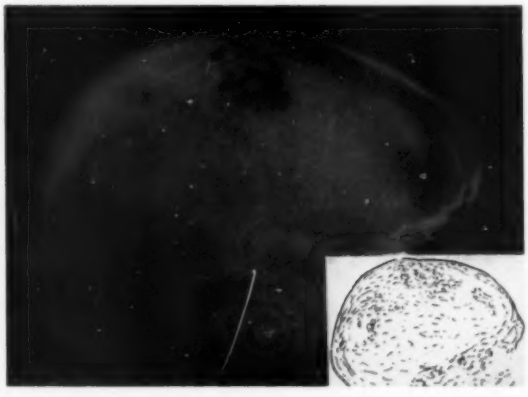

FIG. 24. Osteomyelitis, Syphilitic. This patient, a white male, aged forty-three, complained of dull headaches for the past several months, and transient spells of dizziness. There were two nontender soft tissue masses on the frontal and parietal regions of his head. He claimed that he had accidentally struck his head in those regions several months previously. Note the areas of irregular, moth-eaten erosion surrounded by conspicuous osseous condensation—the bony production even predominant over the amount of destruction. Stereoscopic and tangential studies in this case showed the destruction to involve the outer table. Serology was positive for syphilis. The soft tissue masses subsided and the areas of bone destruction filled in rapidly with the administration of antiluetic treatment. (Courtesy of Dr. Herman Ostrum.)

genography had been employed in his cases, involvement of cranial bones accounted for 42 per cent of the definitely skeletal lues. The frontal and parietal bones are especially prone to attack (probably because they are more subject to trauma). The early stage of a luetic process in the calvarium frequently occurs beneath the inner table.[30,31] This lesion is sometimes spoken of as a "focal meningitis." It may originate superficial to the outer table or it may primarily involve the diploë. Diploic spread is probably the more common but the striking picture is that of erosion through the tables with the production of superficially protruding non-tender osseous and soft tissue masses. These lesions are usually found in adults but are occasionally the result of heredosyphilis[11,40] (Fig. 24).

As is characteristic of tuberculous involvement of the skeleton elsewhere, invasion of the calvarium by the tubercle bacillus usually occurs between the ages of one and ten years. It is rarely seen after the age of twenty, but there have been cases reported as late as sixty.[47] Involvement of the skull seldom represents a primary focus of the disease. Suspicions of the condition here, then, should be corroborated by evidence of involvement elsewhere: the lungs, the lymphatics or the viscera. Two types of lesions have been described in the skull: (1) the diffuse progressive type, early described by Koenig (quoted by Straus[47]), and (2) the cystic or circumscribed type, more recently described by Jüngling.[24] The former signifies less reaction on the part of the patient, and more rapid developments. The diploë are essentially involved with erosions of either table. Complete fenestration through the outer table may result, with the development of soft tissue masses or cold abscesses. Subdural extensions or primary erosion of the inner table is uncommon, though lesions may arise subperiosteally and thus involve the outer table in the beginning. Roentgenographically, the processes first appear as areas of "bone sand," with peripheral gradations as to the degree of rarefaction. Actual sequestration is not as common as in the nonspecific osteomyelites.

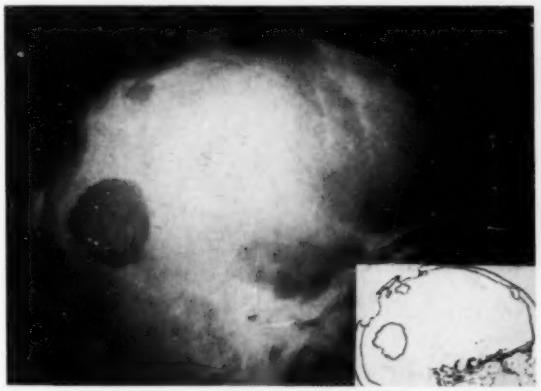

Fig. 25. Osteomyelitis, Tuberculous. This patient, aged forty-six, had been a healthy ice man until about two years previous to the time of this roentgenography. The first signs of his trouble included a listlessness, gradually developing weakness and the appearance of a "lump" on his head. This lump was soft and painless. At times, however, he was bothered with headaches. There were no localizing intracranial manifestations. Physical examination revealed a marked inguinal adenopathy bilaterally. In fact there was a resemblance to bilateral herniae. Otherwise the findings were essentially negative. Biopsy of the skull lesions and also of the inguinal nodes showed granulation tissue with giant cells and marked central necroses as seen in tuberculosis.

The cystic form shows greater tendency toward reaction. It is more insidious in its development and doubtless represents invasion by a well attentuated strain of the organism. Multiple osseous lesions are the rule. The particular sites where other cysts might be expected include the phalanges, the metacarpals or metatarsals or the long bones of the extremities.[45,50] In all of these the involvement usually takes place in the region of the epiphyses. Further emphasizing the avirulence of these lesions, it should be mentioned that biopsies frequently fail to reveal the tubercle bacillus and even guinea pig inoculations of the tissue may be negative, at least for prolonged periods. Moreover, von Pirquet tests frequently show a general systemic negativity. Lupus or sarcoid dermatoses are oftentimes associated. The bone lesions have been reported to heal spontaneously. This type of lesion is quite a contrast to that already

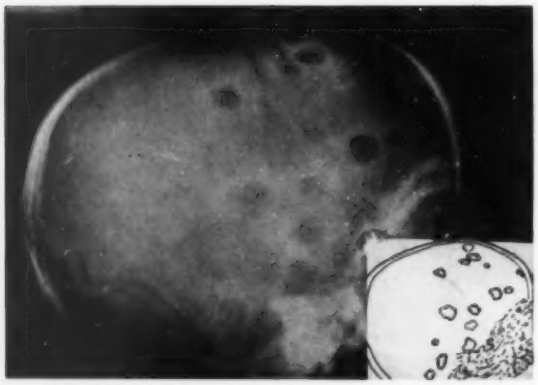

FIG. 26. Osteomyelitis, Tuberculous, Circumscribed. This patient was a colored boy, aged seventeen months. He was brought to the hospital because of "lumps" on some of his fingers, his wrist, an ankle and one foot. These had been noted since the age of six months. One of these lesions had ulcerated. There had been indirect contact with tuberculosis. He weighed only 18½ pounds and presented some evidence of rickets. Besides the skull lesions, shown above, roentgenography visualized similar circumscribed areas in some of the metacarpals, metatarsals, phalanges, and the distal portions of an ulna and fibula. Clinically, he showed a septic temperature curve—varying from 98 to 104°F. Blood count revealed a moderate anemia. Tuberculin tests were negative. Biopsy from one of the lesions in the fibula showed caseation, granulation tissue and typical tubercles. (Courtesy of Dr. J. H. Vastine.[51])

described when seen in the skull. It may be conspicuously circumscribed by dense osseous reaction; it rarely sequestrates or perforates, and multiplicity of lesions, even as regards the calvarium itself, is the rule (Figs. 25 and 26).

Particularly in the region of the frontal sinuses, areas of resorption may occur incident to expansion by a mucocele. These lesions simply represent pressure erosions due to blockage of the drainage channels and over-accumulation of mucus.[21] The outline of the sinus may or may not be extended beyond the expected confines. The distinctive feature is that the area of the mucocele appears less dense, that is, showing greater radiotransparency, than do the regional portions where infection per se is present without the osseous erosion. Usually there is associated a pansinusitis (Fig. 27).

Circumscribed areas of increased radiotransparency might be found in cases otherwise showing evidence of disturbed calcium metabolism. Corroborative evidence of this basis may be seen in other parts of the skeleton.[38] The lesions described as osteoporosis circumscripta may be conspicuous either because of excessive deossification through the particular area, in contrast to the adjoining portions of the skull, or they may be conspicuous because of the laying down of additional osseous tissue in the adjoining bone. Sosman,[44] and others, have emphasized this finding in cases of osteitis deformans. Kasabach and Dyke[25] have pointed out that the lysis of bone is particularly seen in the outer table but may include the outer table plus the diploë. It is important to consider this finding not as an entity but rather as a manifestation of a constitutional condition (Fig. 28).

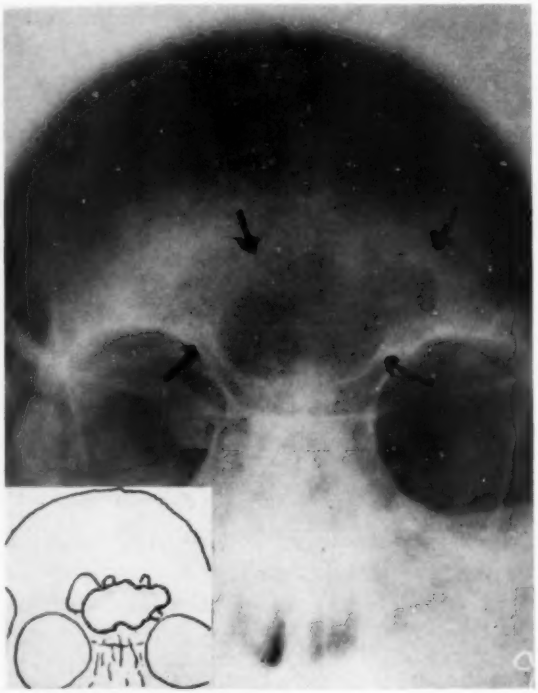

FIG. 27. Mucocele. The patient, a male, aged forty-six, complained of nasal obstruction and "swelling between the eyes" for over two years. The mass was found to be reddened and fluctuant but not tender. There were several polyps in the nasal passages and the frontal sinuses were engorged by them.

Unlike the effects produced by most tumors of the brain, where erosion is the principal manifestation as concerned with the calvarium, meningeal tumors are prone to more intimate involvement of bone. Whether one accept Cushing's original opinions that the tumor cells early invade the tables, thereby producing osteoblastic activity,[10] or Kolodny's ideas that the bone proliferations occur in response to vascular dilatations regional to the growing tumor,[27] it is important to realize that these tumors usually stimulate bone production but they are not always conspicuously osteoblastic. In their early stages, at least, they may be seen to be essentially destructive,[12] and perhaps certain cytological types are basically so. Most of them are probably of fibroblastic origin, arising from the arachnoid layers of the meninges, but a few cases have been found to be entirely extradural.*[,16] These tumors are usually seen in young adults. They occur most frequently in the frontal regions of the skull. Their development is characteristically very slow so that histories in these cases may include mention of headaches or localizing signs for as long as ten years. The earliest roentgenographic manifestations are of indefinite rarefaction, particularly of the internal table. There may be supportive evidence

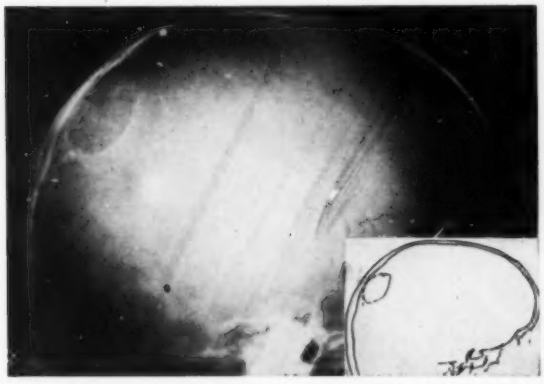

Fig. 28. Osteoporosis Circumscripta. The patient, a child, aged seven, had a history of repeated fractures. The first of these occurred in the right femur at the age of nine months, incident to the mere turning over in bed. This bone has re-fractured repeatedly since then, and fractures have occurred elsewhere in the skeleton. Blood inorganic phosphorus and serum calcium values were not significantly above normal. Deossifications in the long bones were conspicuous, particularly in the metaphyseal regions and the epiphyses. The area of conspicuous decrease in osseous density in the calvarium, demonstrated above, might represent the effects of trauma, but these localized patches of deossification, as seen in parathyroidism, including osteitis deformans, are simply spoken of, at times, as osteoporosis circumscripta.

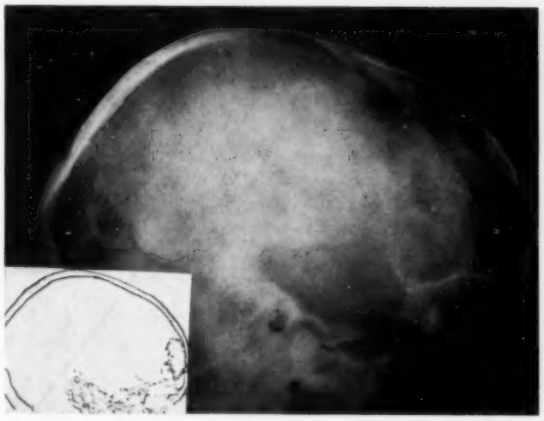

Fig. 29. Meningioma. A male, aged thirty-five, complained of frontal headaches, blurring of vision, diplopia and "loss of pep." These symptoms were of relatively late development, having been conspicuous for only eight months. They were progressive in their severity so that of late they had definitely crippled the patient. Though he was usually somnolent when left alone, with exertion he became alert and he was intelligently cooperative. There were no localizing neurological manifestations. Roentgenographically, in addition to the area of erosion in the frontal region demonstrated above, there was visualized a marked atrophy of the dorsum sellae and of the posterior clinoid processes. The frontal sinuses were hazy. A meningioma ("dural fibroblastoma"), measuring about 8 cm. in diameter and apparently arising from the olfactory region, was removed.

* While considering this type of lesion, mention must be given of the case reported by Fraser,[15] which was diagnosed as a "benign giant cell tumor." There was the background of trauma to the frontal region, subsequent painless swelling with the roentgenographic evidence of bone absorption, and peripheral extension into the regional diploic space. It was found to be composed of broken down blood elements and to contain strands of thickened bone throughout. Both tables showed erosion but the lesion did not extend beyond the dura. The diagnosis was made on the basis of masses of giant cells containing large nuclei and endothelial-lined blood spaces. In view of the paucity of reports of benign giant cell tumor occurring in membranous bones and the possibility of this case having been a meningioma the pattern of which was changed by the roentgen therapy given, the inclusion of benign giant cell tumor among the conditions producing lysis of the calvarium is reserved.

FEATURES DISTINGUISHING THE INTRA-OSSEOUS LESIONS OF THE CALVARIUM

Condition	Usual Age	Number of Lesions	Usual Location	Roentgenographic Manifestations	Roentgenographic Evidence Elsewhere	Clinical Features	Laboratory Corroboration
Traumatic lesions	Any; residua from infancy most evident	Usually single	Variable; external, or both tables involved	Defects usually sharply outlined even though borders may be very irregular	None expected	Background of trauma, particularly during infancy, or more recently	If recent injury, perhaps xanthochromic discoloration of spinal fluid
Metastatic lesions	Over 30	Usually multiple	Diploë; either table may be expanded	Variable as to type of metastasis; borders may be clearcut but usually without peripheral osteoblastic evidence; they are usually irregular. The destruction may appear diffusely infiltrative, or there may be an infiltrative osteoblastic appearance	Perhaps roentgen visualization of the primary itself; search for other metastases should include the spine, pelvis, femur and ribs	Variable, depending upon the site of the primary lesion. Locally, dull boring headaches; perhaps palpable masses extending from the surface of the skull—they may subside, periodically. Ultimate loss of weight	In earlier stages, blood may show regenerative forms—ultimate secondary type of anemia (particularly when the primary is in the gastrointestinal tract). Urine may contain Bence-Jones protein
Plasma cell myeloma	Over 40	Almost always multiple	Diploë; both tables usually eroded	Usually round, clearcut, punched-out appearing lesions, which in true cross section of the tables may show an undermining effect—due to pulsation erosion; osteoblastic reaction usually lacking. Little response to roentgen therapeutic test	Perhaps the finding of the "mother lesion," particularly in the spine, ribs, sternum or *upper* portion of the long bones (extension into the regional soft tissues common) generalized medullary lesions	Vague indefinite rheumatic episodes, aggravated by motion or pressure; attacks progressively increasing in severity; frequently, spontaneous fractures, particularly of the ribs (with pleuritic pains) and long bones	Urine usually contains quantities of albumin; often, Bence-Jones protein. Blood may show slight anemia and myelocytes plus increased eosinophiles. Biopsy shows blood elements plus many plasma cells
Endothelial myeloma	Under 25 (occasionally up to 60)	Usually multiple	Diploë; especially of the occipital region	Usually a diffuse mottling as seen in infiltrative metastases; erosion of the diploic aspect of either table, with little tendency toward osteoblastic reaction or expansion of the tables (since these lesions are late manifestations). Favorable response to roentgen therapy	Primary lesion may be found—particularly in the *diaphyseal* regions of the long bones, or in the ilium, scapula, clavicle or vertebrae. Usually, mottled erosions in the medullary regions with "onion-peel" thickenings of cortices	Oftentimes the background of trauma (within 4 to 6 months) in the case of a frail type of individual; the development of an aching pain, intermittent in severity, aggravated by pressure to region; perhaps local redness and swelling; fever	Albuminuria; possibly secondary anemia and leukocytosis. Biopsy findings of compact areas of small polyhedral cells, scant in cytoplasm, and practically stainless, eosinophiles and possibly plasma cells
Chloroma	First decade (though reported up to age of 62)	Usually single	Diploë; with expansion or erosion through outer table	Usually sharply outlined area of definite destruction; osteoblastic reaction at the periphery not uncommon, as well as the appearance of osseous strands through the lesion, even extending out into an epicranial mass, if present	In about one-third of the cases, particularly when there are multiple lesions in the skull, the long bones are involved. Lymphatics frequently involved, especially in mediastinum	Usually frail anemic infant presenting a conspicuous mass on the head; perhaps diastasis of the sutures; mass tender to palpation; perhaps conspicuous lymphadenopathy and enlargement of liver and spleen	Usually leukocytosis; perhaps leukopenia; red blood cells usually reduced with low color index. Biopsy shows tissue of greenish-yellow color containing myelogenous elements and plasma cells
Xanthomatosis	Under 20 (occasionally seen much later)	Single or multiple	Originally subdural or periosteal; both tables early eroded	Irregularly outlined areas of dissolution; usually no peripheral condensations, but lesions clearcut because of the completeness of bone replacement; edges may be beveled inwardly (if subdural extensions)	Frequently similar lesions in maxilla or mandible; pelvis, scapula, ribs, vertebrae or long or short-long bones; lesions usually begin subperiosteally; lungs may show marked fibrosis	Perhaps fairly recent infectious disease; development of bone aching; perhaps exophthalmos, diabetes insipidus, enlarged liver or spleen or superficial xanthoma of the skin	Variable blood and urine manifestations dependent upon the tissues most involved; biopsy shows perivascular foam cells laden with fat, connective tissue and perhaps giant cells
Cholesteatoma	Puberty (though attention may be delayed for years)	Single	Variable; subdural, internal table; diploë or outer table	Clearcut dissolution, frequently showing a peripheral condensation of bone; border often smooth, though it may be irregular (especially when inner table is primarily involved)	None to be expected, though other anomalies may accidentally be noted	Headache usually noted soon after the development of the cyst—about the age of puberty—both it and the cranial mass often ignored for years. May be no other symptoms or there may be all the signs of intracranial invasion	Biopsy finding of a pearly white, glistening cyst wall containing epithelial débris; histologically, an epithelial wall containing lamellated desquamations and intermeshed lipoid

Hodgkin's granuloma	20 to 40	Usually single	Diploë; secondarily, either table	Usually diffuse osteolytic lesion, essentially concerned with the diploë, but producing erosion of either table, and possibly expansion of them; frequently, borders show irregular osteoblastic reaction	Frequently evidence of mediastinal enlargements; pulmonary infiltration, or involvement of other bones, especially the vertebrae, sternum, pelvis, femur or ribs	Very frequently, unbearable pruritus, without manifest skin lesions; perhaps superficial adenopathies or enlargement of the spleen. Characteristically, fatigability, Pel-Ebstein fever	Usually some secondary anemia. Biopsy findings of epithelioid cells with numerous eosinophiles and "Dorothy Reed" giant cells
Osteomyelitis, nonspecific	Under 20 (though may be seen at any age)	Usually single, in early stages	Frontal, temporal, or occipital bones; diploë, then tables	"Moth-eaten" erosions along diploë, usually extending from paranasal or mastoid sinuses; erosions of either table, though particularly of the external; bone destruction, sequestration and bone production	Paranasal or mastoid sinusitis; perhaps osteomyelitis elsewhere	Usually, the symptomatology of acute sinus involvement; perhaps the background of trauma or skin infections. Fever usually over 100°F. Locally boring pains and possibly swellings—which may be aggravated by a roentgen therapeutic test	Leukocytosis with increase of polymorphonuclears, early; later, leukocytes may show little increase. Positive aspiration cultures
Osteomyelitis-syphilitic	After 20 (though may be seen in heredosyphilis earlier)	Single or multiple	Frontal or parietal regions; either or both tables may be eroded	Erosions may be seen in inner surface of internal table (focal meningitis); in the diploë, or involving the external surface of the outer table; bone production is usually early conspicuous	Perhaps productive lesions on tibia, sternum, ribs or clavicle, in the adult; diaphyseal erosions of the long bones plus concentric rings in the epiphyses, in infants	Background of acquired or heredosyphilis; perhaps stigmata of syphilis such as superficial gummatous ulcerations, cardiovascular signs, etc. Perhaps local tumescences with response to antiluetic treatment	Positive serology; blood or spinal fluid. Biopsy may reveal the typical perivascular infiltration and the *Spirochaeta pallida*
Osteomyelitis-tuberculous	1 to 10; uncommon after 20	Usually multiple	Variable as to region; diploë or outer table especially involved	Usually a localized granular deossification showing peripheral gradation of radiotransparency; rarely, sequestration. Rarely, circumscribed areas of destruction, usually of both tables, with peripheral condensation of bone	Tuberculous involvement of the lungs, the viscera, the lymphatics or elsewhere in the skeleton. In the circumscribed type, oftentimes similar lesions in phalanges, short-long bones or the extremities of the long bones	Variable according to the location of the primary lesion. Usually headache, soft tissue tumor and possibly cold abscess. Perhaps lipoid or sarcoid dermatoses	Positive tuberculin test. Positive guinea pig inoculation. Biopsy showing of epithelioid, lymphoid, and giant cells plus caseation and perhaps the tubercle bacillus
Mucocele	After 20	Usually single	Adjoining frontal sinuses	The regional sinuses should be clouded; area of mucocele usually bluntly rounded, and revealed by greater radiotransparency; contrasted with regional portions of sinus, the latter showing less radiotransparency because of lack of osseous destruction	Evidence of chronic sinusitis; perhaps polyp formation	Nasal obstruction; extreme boring headaches, usually worse in the mornings; postnasal drippings	Perhaps mild leukocytosis
Osteoporosis circumscripta	Any	Single or multiple	Variable as to region; outer table especially involved	More or less circumscribed area of increased radiotransparency; regional bone may show comparatively normal density or even density greater than normal—as in osteitis deformans (where osseous deposits may be found in the diploë)	Evidence of deossification in the metaphyseal reserve sites of the long bones, or of reossifications in these regions; perhaps definite osteitis deformans	Variable, depending upon the constitutional condition. May be the background of trauma, parathyroidism or other glandular or acid balance deossification	Perhaps increase in serum inorganic phosphorus or calcium
Meningioma	30 to 50	Single	Sphenoidal, frontal, parietal or temporal regions; erosion of inner table	Most frequently hyperostosis of the inner table; occasionally instead, erosion of it. In the former instance, perhaps perpendicular striations extending through both tables, and beyond the inner and outer confines of the skull	Perhaps evidence of pineal shift; increased intracranial pressure as evidenced by erosions of one or more clinoid processes or of the sella turcica	Usually prolonged headaches with the gradual development of symptoms of increased intracranial pressure: severe headaches, vomiting, dimming of vision, dizziness, lethargy, etc., and even of localizing neurological signs	Nonspecific

of increase in the intracranial pressure. Many cases show calcifications in the lesion itself. Even more to be expected are hyperostoses, at first comprising localized osseous deposits in the diploë; later, including osseous striations perpendicular to the tables (Fig. 29).

As a final consideration, it should be emphasized that studies of the skull require stereoscopic projections plus anteroposterior, posteroanterior and tangential views. The various features detailed above concern one or more of the several levels: namely, the inner aspect of the inner table, the inner table itself, the diploic space, the external table, or the surface of the external table. It is important to consider which of these levels was primarily involved and the mode of the extension of the process. This analysis, along with any roentgenographic evidence elsewhere, plus the support of clinical and laboratory corroborations, guides one to the diagnosis. The accompanying table may serve as a guide.

We wish to express our appreciation for the clinical records supplied by the Surgical, the Neurosurgical and the Medical Services of the Hospital of the University of Pennsylvania.

Since sending in this manuscript for publication another condition "bilateral parietal foramina," an anomaly, has been brought to our attention. This condition was described by Dr. O. H. P. Pepper, and Dr. E. P. Pendergrass, at the 36th Annual Meeting of the American Roentgen Ray Society, 1935. It consists of two symmetrical openings in the skull occurring at the sites of the parietal foramina. It is hereditary, the openings varying in size from 2 mm. to 2.5 cm. It occurs in both males and females. It does not cause symptoms and it may simulate trephine openings in the skull, Hand-Schüller-Christian's disease and many other osteolytic lesions. This note was made possible through the courtesy of Dr. Pepper who deserves the credit for bringing this interesting anomaly to the attention of roentgenologists. The article appears in this issue (see p. 1).

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METABOLIC CRANIOPATHY*

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ST. LOUIS, MISSOURI

THIS communication is founded on the study in chronological order of approximately 20,000 roentgenograms of the skull of 6,650 individuals, analysis of 193 case histories, a roentgenographic investigation of the skull of 36 insane patients, the examinations of 660 dried skulls and during the past year study of 6 patients.

This work was begun some years ago with the object of reaching an understanding of the nature of an overgrowth of bone, observed on rather rare occasions in roentgenograms of the skull. In the course of examining the roentgen negatives it was found that there were three additional types of calvarial change and possibly a fourth. None of the types could be identified with any known cranial abnormality or as a cranial manifestation of any disease process. The literature was casually examined, unsuccessfully, from time to time and only systematically in the past year. Neither a name nor a description of the condition was discovered until a name was coined to describe the first and most characteristic of these cranial abnormalities. This was "hyperostosis frontalis interna." It was clear that a name so obvious and a description of a condition so distinct must be found in the *Quarterly Cumulative Index Medicus*, as indeed it was. This is the thesis of Ferdinand Morel: "L'hyperostose frontale interne. Syndrome de l'hyperostose frontale interne avec adipose et troubles cérébraux,"[5] published in 1930, which was based on the autopsy material from 15 examples of the condition and 1 living case. There have been 2 living cases reported subsequently; those of Van Bogaert and Schiff and Trelles. For the literature dealing with the condition, which though meager is very old, the reader is referred to Morel's thesis.

In the material examined there were 72 roentgenograms showing hyperostosis frontalis interna. When assembled it was found that they constituted a striking roentgenographic entity. For this reason three of the other four groups of cranial change were critically scrutinized and it was found that, though distinctly less characteristic than hyperostosis frontalis interna, they were nevertheless distinctive. As no description or name for these groups of skull changes has been found the following terms in order of their definiteness were fashioned for them: nebula frontalis, hyperostosis calvariae diffusa and hyperostosis frontoparietalis (Fig. 1).

These terms and hyperostosis frontalis interna are regional in application and though suitable roentgenologically do not convey the associated constitutional phenomena clearly shown by the clinical facts which are to follow. Therefore, and for the additional reasons that the metabolism is evidently at fault and the clinical findings are practically identical, the term "metabolic craniopathy" is employed to include all four groups of skull changes. What this term may lack in other respects is compensated for by its brevity. It will serve provisionally until greater knowledge of the unknown factor producing both the skull change and the constitutional effects determines a superior designation.

Of the five groups of skull changes found, four have hypertrophy or overgrowth of bones of the skull as a feature. The remaining group, not yet investigated, if it proves to be an entity, is the antithesis of the others, being characterized by localized thinning of the skull.

The hyperostoses of the skull are of two orders. In one the process involves the compact bone of the inner table with later

* From the Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Mo.

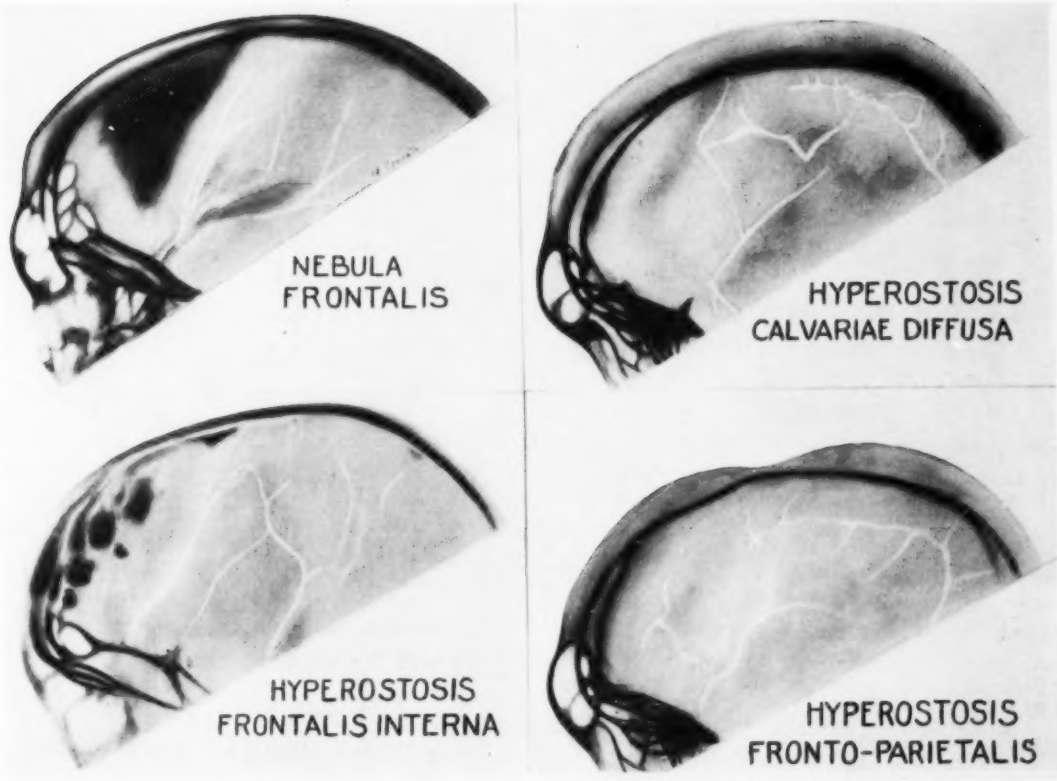

FIG. 1. Diagrammatic representation of the four types of the hyperostoses; drawn from roentgenograms; intensified but not magnified.

some change in the adjacent diploë and in the other the change is limited to the diploë without alteration of the compact bone of the tables. The different types have regional distribution, all are bilaterally symmetrical and all four may be found in one individual.

Hyperostosis frontalis interna (Fig. 2) has been described elsewhere[4] and but brief reference will be made to it. In this condition newly formed cancellous bone, very dense, is deposited on the inner table of the squama frontalis. This deposit may be either nodular or sessile and varies in degree from that which is detectable to masses of bone 1 cm. or more in thickness. With one questionable exception the vault of the skull does not have these deposits as the bone does not form beyond the coronal suture. The hyperostosis may extend to the orbital plates of the frontal bone and at times appears to be limited to those structures. In a dried skull extensive deposits were observed on the squama temporalis. The intracranial aspect has an outline, wavy in the nodular and regular in the

FIG. 2. Lateral roentgenogram of skull showing hyperostosis frontalis interna.

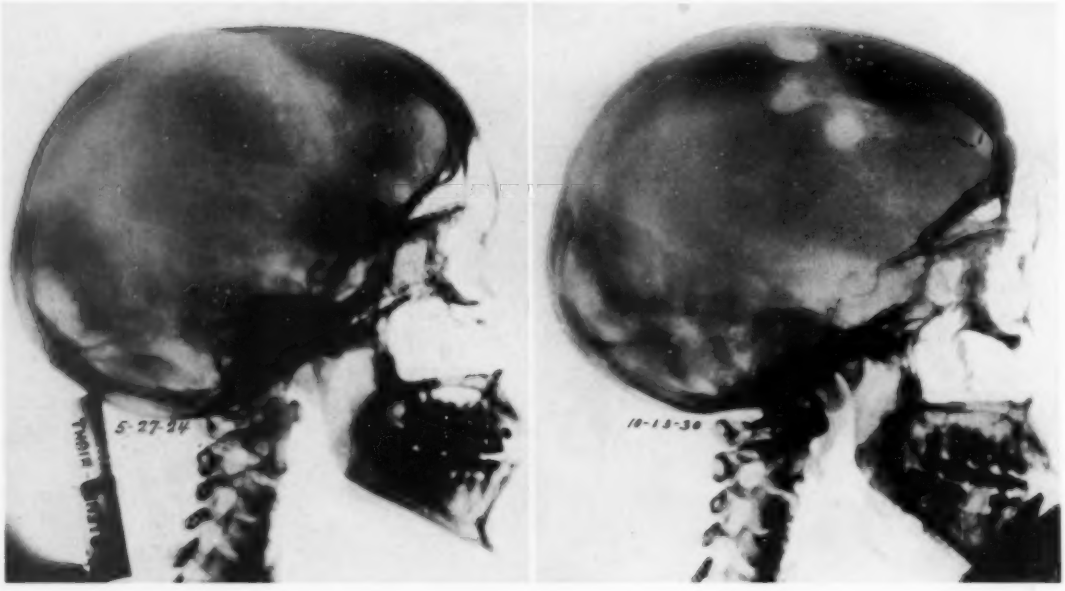

FIG. 3. Lateral roentgenograms of skull in nebula frontalis. Note dates and progression. Patient subject to convulsive seizures. Exploratory craniotomy. Arachnoiditis found.

sessile forms, and is smooth. There is no change of the skull externally. Neither progression nor diminution of the masses of bone has been observed in the few instances in which examinations over a period of years have been made. When well developed, the roentgenogram in either the lateral or posteroanterior projection is pathognomonic.

Nebula frontalis (frontal cloud) (Fig. 3) is seen as a triangular or ovoid area of density and thickness in the squama frontalis with a broad base in the sagittal plane. It is a process limited to the diploë with the tables unaffected. It is a condition much less distinct than hyperostosis frontalis interna and for the reason that its location does not permit of its being brought into profile for roentgenographic purposes, it is difficult to find. The variations are many and much depends on the personal equation in determining its existence. Unlike hyperostosis frontalis interna, progression of the change in the bone over a period of years has been demonstrated in 3 patients (see Fig. 3).

FIG. 4. Laternal roentgenogram of skull showing hyperostosis calvariae diffusa. Note uniform thickening of vault of skull. Thickening is not in proportion to skull size.

Hyperostosis calvariae diffusa (Fig. 4) has a general even increase in the volume and density of the diploë of the vault of the skull. Except that it is not regional it appears to be a process identical with that of nebula frontalis. It is even more difficult to detect than the last named, and for the same reasons. Because of bone density and thickness the roentgenogram will lack detail, the impressions of the convolutions are faint or invisible, the vascular grooves are deepened and though those which are ar-

terial may become faint in the roentgenogram, the venous sinuses are more apparent than in the normal. In the dried skull the depth of the latter is sometimes profound. The squama occipitalis and temporalis occasionally project outward where they participate with the parietalis in a bevel joint. This is due seemingly to the increased volume of the diploë in the two members of the articulation. In this condition the size of the skull is not commensurate with its thickness. It cannot be said that the skull is enlarged externally but there is some degree of enlargement internally, and this is significant.

Fig. 5. Lateral roentgenogram of skull showing hyperostosis fronto-parietalis. Note maximum thickening at center of frontal and parietal bones.

Hyperostosis fronto-parietalis (Fig. 5) is also diploic and roentgenographically the change in that tissue is identical with that of hyperostosis calvariae diffusa and nebula frontalis in every respect except that of its location. The maximum thickening is at the central points of the squamous portion of the frontal and parietal bones. This produces an even, gentle grooving of the skull at the site of the coronal and sagittal sutures. This hyperostosis is the least definite and most infrequent type. Hyperostosis fronto-parietalis and nebula fron-

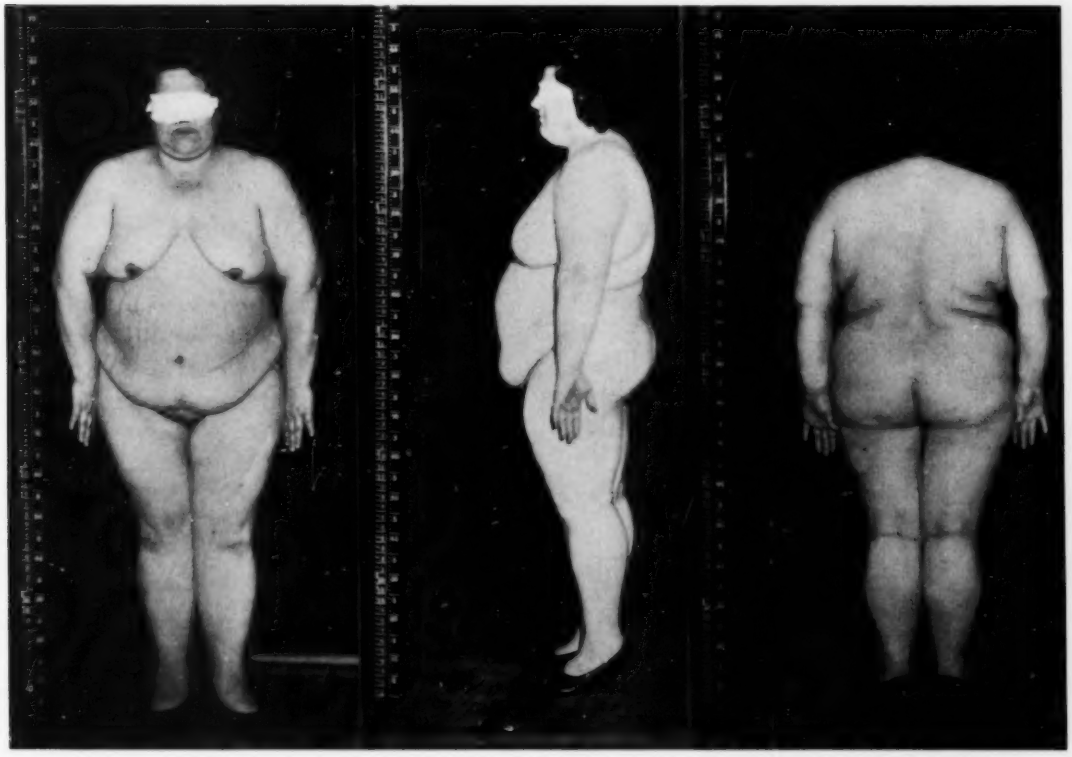

Fig. 6. Photograph of patient with hyperostosis frontalis interna. Note maximum accumulation of fat about the limb girdles, best visualized in the posterior view.

FIG. 7. Illustrating growth of hair in female. Photograph made following radical operation on paranasal sinuses.

talis may prove to be only stages in the development of hyperostosis calvariae diffusa. Calcification (ossification) in the falx cerebri is noted occasionally in all four types. I have elsewhere advanced the theory that the presence of excess of calcium in the organism is a factor in the production of the hyperostoses. Greig[3] and Morel[5] had previously advanced a similar idea.

In the 6,650 individuals roentgenographed there were 96 examples of hyperostosis frontalis interna, 76 of nebula frontalis, 40 of hyperostosis calvariae diffusa and 17 of hyperostosis fronto-parietalis, an incidence of 1.44 per cent, 1.14 per cent, 0.6 per cent, and 0.3 per cent respectively. It is significant that more than half of the patients roentgenographed were males.

Case records of 193 were available and were analyzed. The clinical facts revealed patterned themselves into a symptom-complex which is as striking as the roentgen findings.

These patients with a few exceptions had neurological and neuropsychiatric symptoms of an intensity requiring a roentgenographic examination of the skull. The great majority of them were hospitalized. There was an indefinite but long history of morbidity. Individually, the records leave an impression of vagueness and there is an unsatisfying diagnosis on discharge. There is a notable absence of organic disease except as an unrelated complication. The symptoms found and the physical examination do not form a part of any particular pathological state, but they might be a part of many disorders.

The syndrome is a combination more or less constant of the following: headache, often disabling and, in the case of hyperostosis frontalis interna, frequently referred to the forehead with occasional tenderness and a feeling of pressure; obesity (or a tendency to obesity) which may be extreme and is of the rhizomelic type (Fig. 6). Scott[6] calls attention to the fact that the breast in the female cases is larger and more pendulous than is the case in obese individuals who do not have cranial hyperostosis; easy fatigue and actual muscular weakness; nervousness and a tendency to worry, and depression; dimness of vision and occasionally diplopia; epileptiform seizures; impairment of memory; mental slowness in the lesser grades and dementia in those of full development; dizziness; disturbance of equilibrium and gait; seventh nerve weakness is also frequently noted; occasionally there is speech difficulty apparently motor; a recent case relates loss of the sense of smell; neuralgia of the fifth nerve is observed apparently as a complication; sensory disturbance such as numbness and tingling regional in character is occasionally found; there may be dragging of a lower extremity or weakness of any extremity; transitory hemiplegia and hemiparesis occur occasionally, and there is a general neuromuscular insufficiency; overgrowth of hair on the chin, less frequently on the upper lip, in the female is often noted (Fig. 7). The incidence of the disorder in the sexes is 98 per cent women. There is no evidence of racial selection, and a familial factor is yet to be found.

As evidence of the indefiniteness of the symptoms in the patients with neurological or neuropsychiatric symptoms is the fact that some were thought to have incipient paresis or multiple sclerosis, and 13 were diagnosed "brain tumor suspects." These latter cases were suggestive of the early stage of brain tumor or of tumor located in a silent area. All such patients lacked demonstrable organic cerebrospinal lesions. The nerve and muscular weakness resembles in some respects that occurring in chronic intoxications and in diseases such as pellagra and beri-beri.

Thyroid disorder was associated in 4.4 per cent of the patients and there were 3 clearcut examples of acromegaly in the hyperostosis calvariae diffusa group. To digress for a moment. It was found that 17 unmistakable examples of acromegaly did

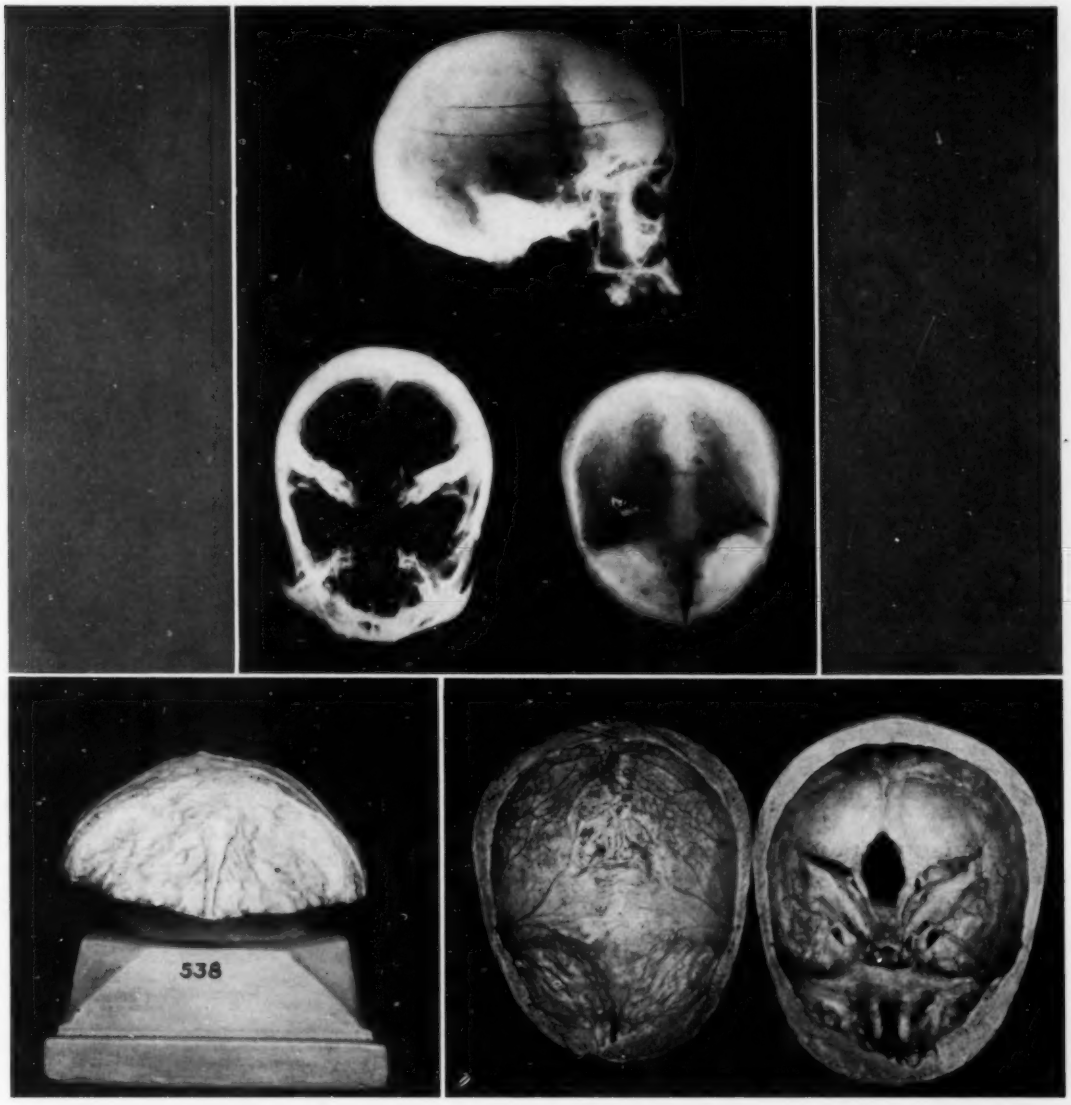

Fig. 8. Example of hyperostosis frontalis interna. *Above:* Lateral, vertical and basilar roentgenograms of dried skull. *Below:* Left, plaster cast of interior of skull cap shown above which demonstrates encroachment of hyperostosis on contents of cranial cavity. Right, photograph of interior of same skull.

not have increased thickening of the calvaria and enlargement of the skull was restricted to its visceral portion.

Of 36 insane patients, 3 men and 33 women, 14 lacked a specific psychiatric diagnosis, 7 presented the roentgenographic evidence of hyperostosis. Subsequently the remaining 22 patients were examined, with the discovery of 7 additional cases. The psychiatric diagnosis in these latter was not convincing. No male example was found.*

In a further search for material to throw light on this condition it was possible through the generous cooperation of Dr. Robert J. Terry, Professor of Anatomy, Washington University School of Medicine, to examine his invaluable osteological

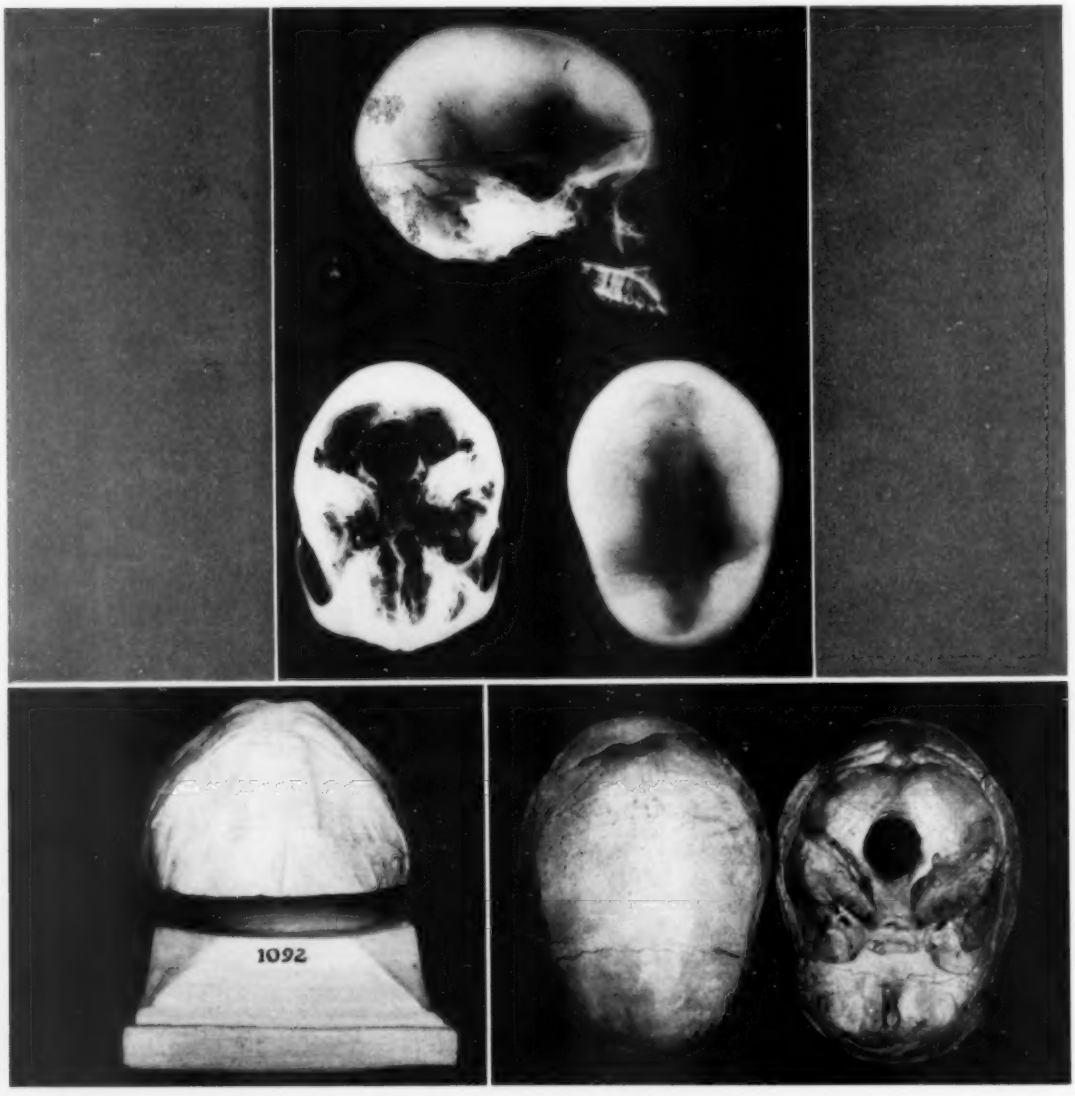

Fig. 9. Example of nebula frontalis. *Above:* Lateral, vertical and basilar roentgenograms of dried skull. *Below:* Left, plaster cast of interior of skull cap shown above. Faint bilateral indentation in the frontal region. Right, photograph of interior of same skull.

* My thanks are due to Hospital Commissioner R. L. Thompson, Superintendent M. F. Grogan and Resident C. H. Nestor for the opportunity to examine these patients.

collection. This is composed of some 1,200 skeletons which were examined and among which 660 skulls were found suitable for study. Among them were 24 cases of hyperostosis frontalis interna (Fig. 8), 13 cases of nebula frontalis (Fig. 9), and 3 cases of hyperostosis calvariae diffusa. Examination of these skulls and their roentgen appearance amply confirmed the impressions gained from roentgenograms in the living cases. There is an interesting sidelight to be found in the fact that the incidence drops from 98 per cent females to 20 per cent, but against this it is to be noted that there were 10 examples of hyperostosis in 529 males and 30 among 131 females, percentages of 1.9 and 23.

Both the normal and abnormal calvariae were measured for thickness at 4 points, 2 right and 2 left, the intersection of a perpendicular through the frontal and parietal bosses with the conventional cut used in removing the skull cap. Since the level of the last is variable and the frontal and parietal eminences are not definite points, the measurements will not satisfy the conditions of exact craniometry. However, the error should apply equally for both normal and abnormal skulls and hence be of comparative value (Table 1).

Table I

	Average Thickness in mm.			
	Frontal		Parietal	
	R.	L.	R.	L.
Normal (582 specimens)	4	4.25	3	3.25
Hyperostosis frontalis interna (29 specimens)	6	7	4	4
Variations in mm. thickness				
	Frontal		Parietal	
	R.	L.	R.	L.
Extreme	19	20	11	11
Minimum	3	4	3	4
Nebula frontalis (14 specimens)	9	8	5	5
Variations in mm. thickness				
	Frontal		Parietal	
	R.	L.	R.	L.
Extreme	12	11	4	5
Minimum	7	7	5	5
Hyperostosis calvariae diffusa (3 specimens)	6	6	5	5
Variations in mm. thickness				
	Frontal		Parietal	
	R.	L.	R.	L.
Extreme	7	7	6	6
Minimum	6	7	6	6

It will be seen from the table that the percentage of increase of thickness in the abnormal cases varies from minus 75 per cent in hyperostosis frontalis interna (in a young negress dead of chronic tuberculosis) to plus 500 per cent in the extremes, with a mean of plus 150 per cent. The percentage in nebula frontalis, fewer in number, was minimum plus 175 per cent, extreme plus 300 per cent, mean plus 225 per cent.

The cases of hyperostosis calvariae diffusa were too few to be worthy of calculating the percentage.

A gross examination of the remaining bones of the skeleton in those cases having a hyperostosis, as was the case in a few patients, did not supply sufficient incentive to lead to any extensive roentgenographic skeletal studies. The bones having any changes presented only those to be expected in the particular age period in which the individual belonged and they in no wise differed from like changes found in those skeletons considered normal.

There has been no opportunity to study the pathology of these hyperostoses except that found in the literature. The two important communications are those of Stewart[7] and Morel,[5] both of whom discovered the presence of immense collections of fat both pannicular and in the body cavities. There is also fatty infiltration of the skeletal muscles. The observations of both these writers were directed to hyperostosis frontalis interna only. In this condition they report that the frontal bone and the dura are free from any signs, or present or antecedent inflammation. Stewart describes changes in the pituitary which he considered to be only those to be anticipated in old people. Morel reported a granular degeneration in the wall of the third ventricle which he considered constant, important and characteristic. From this he infers that there is a center for the control of calcium metabolism in that location. Only one protocol of an autopsy was available, in a patient dying of septic meningitis, with the findings usual in that condition.

The ultimate causation of calvarial hyperostosis and the accompanying clinical phenomena is conjectural but it is probable that there is a single factor which produces both the symptoms and hyperostoses.

The 6 cases in whom intensive clinical studies have been made have not established the fact that there is a clearcut metabolic disorder. Carr[1] found that there was a low basal metabolic rate, increase in sugar tolerance; serum calcium and phosphorus have shown no change, but the period of observation for this has been too limited.

A differential diagnosis must first separate these conditions from those which have as a feature hypertrophy or overgrowth of bone, and secondarily, from diseases in general. The hyperostoses cannot be identified as a part of any of the bone dystrophies as they are at present known. This is true because of their inherent characteristics of location, symmetry, physical characteristics and sex incidence. Since the overwhelming majority of cases occur in the female, its separation from those diseases which have an equal or nearly equal distribution in the sexes is unnecessary. The hyperostoses and the associated phenomena cannot be identified as a feature of those disorders which are restricted in their occurrence to women as such disorders are at present known.

The roentgenographic incidence by sexes is 225 females and 4 males. From this it appears that the condition must be due to a disorder of some structure peculiar to the female which is as yet unknown.

Reproduction is closely related to new formation and growth of bone intracranially as is shown by the fact that in pregnancy deposits of bone are frequently discovered on the inner tables of the skull, the "puerperal osteophyte" of Rokitansky. Dreyfus[2] claims that their presence can be demonstrated roentgenographically in 30 per cent of pregnant women. There is an additional factor related to the growth of the bones of the skull found in the physiological hyperpituitarism or "fugitive acromegaly" of pregnancy. It is proposed as a working hypothesis that the hyperostoses are the manifestations of a disorder chiefly of calcium and fat metabolism and that it is the expression of the frustration in some phase of the function of reproduction for which the particular organism was designed by nature. This might be frustration in time or degree. However, the condition does occur in the male.

The hyperostoses are by no means so uncommon that the dried skull constitutes a museum specimen as has been the case in the past. During the past twelve months there were skull examinations of 695 individuals, 42 cases having hyperostoses. The condition is readily found roentgenographically and I believe with equal readiness by clinical examination. In its lighter phases these patients have an unhappy lot. In the more profound examples the disorder is a major tragedy. There is no specific treatment yet in view. To offset this, however, is the fact that there are certain rational indications upon which treatment could be based. These are of two orders: measures to combat the metabolic imbalance when the existence of such can be established, and measures which are to be considered as local treatment where important structures are jeopardized by the volume of the hyperostotic bone. This applies chiefly, of course, to hyperostosis frontalis interna. Measures should be taken to conserve the muscular strength of these individuals. It is a question whether nerve insufficiency causes the muscular weakness, or the reverse. However, treatment should be directed to the improvement of both.

The patients on whom these studies were made had been treated for many conditions from which they were not suffering. Probably the greatest value which is to be derived from the facts that have been presented is that patients with hyperostosis need not be treated for something which they do not have.

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EXTRAPERICARDIAL FAT BODIES*

By FRIEDRICH G. KAUTZ and MAX PINNER
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AMONG the shadows of varying density along the lateral cardiac borders only a few are referable to anatomical changes of the heart itself. In differentiating these shadows from the cardiac shadow one has to know the extracardial conditions that may give rise to densities in order to avoid misinterpretations. It is well known that involvement of the pericardium and localized changes in the adjacent pleura and pulmonary tissues may produce shadows overlapping the cardiac apex and the right lower cardiac border. The following conditions must be thought of:

1. Right-sided spinal lesions, such as scoliosis with convexity toward the right, and spinal tumors.
2. Lesions of the sternum and ribs.
3. Pleuro-pericardial and mediastino-diaphragmatic adhesions, and pleuro-mediastinal effusions and thickenings.
4. Mediastinal tumors and esophageal lesions.
5. Diseases of the pulmonary parenchyma, of the medial parts of the right lower and middle, and occasionally also of an accessory lower lobe (infiltrations, fibrosis, tumors, bronchiectasis, atelectasis).

On the right side the shadow of the inferior vena cava and the lateral wall of the hepatic vein can at times produce a shadow in the cardiophrenic angle. All the above mentioned shadows may occasionally overlap the right cardiac border; in such cases it is often impossible to differentiate the cardiac shadow proper from the extracardiac shadows, even though films be taken in all possible diameters.

In addition to the densities produced by normal and pathologic conditions there are seen sometimes in both cardiophrenic angles light, approximately triangular, shadows with a slight lateral convexity; they have been described by Schwarz,[7] Römheld,[6] Brauer,[2] Assmann,[1] Herrnheiser,[3] Köhler,[5] and others, and they are interpreted as elongations of the pericardium which are more marked in the inspiratory than in the expiratory phase. Their density is sometimes very slight, and they are usually overlooked during roentgenoscopy. Films facilitate their visualization. It is important to know their occurrence in order to avoid faulty measurements of the size of the true cardiac shadow.

In 1910, Schwarz directed attention to similar shadows overlapping the cardiac apex, and he interpreted the small triangular shadow of soft density as an extrapericardial deposit of fat (Fettbürzel). He confirmed this interpretation by post-mortem findings. Such fat bodies are not necessarily associated with fat infiltration of the myocardium and they are seen at times in non-obese patients. Further roentgenologic examinations proved the existence of such shadows as reported by Schwarz, and a number of papers appeared following Schwarz' publication in favor of or against the original interpretation.

After reviewing a large roentgenologic material and evaluating the very few observations in the literature, we reached the conclusion that under certain circumstances extrapericardial fat bodies may be visualized roentgenologically.

Such shadows are seen between the cardiac apex and the dome of the left diaphragmatic leaf; they are either continuous between these two structures or they are separated from the latter by a narrow zone of lesser density. They may be equal in density with the cardiac shadow or they may be considerably softer. The lesser density of the shadow cast by the fat body as compared to the cardiac shadow is due to three conditions: (1) the greater opacity of the heart as compared with that of fat tissue; (2) the greater anteroposterior

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diameter of the heart as compared with that of the fat bodies, and (3) the lesser diameter of air-containing pulmonary parenchyma in the axis of the rays traversing the heart than those traversing the fat bodies.

Assmann mentions, in one case, the observation of a triangular shadow in the right cardiac angle that was caused by fat tissue as proved by autopsy. In this case of decompensated mitral failure the heart extended far to the right side, so that the inferior vena cava was situated behind the dilated right auricle. An accumulation of fat tissue was found attached to the external side of the pericardium immediately above the diaphragm, filling in the right cardiophrenic angle. Assmann quotes Herrnheiser as having differentiated similar fat bodies from the vena cava by measuring the depth of the shadow.

Greene[1] says, "Fatty overgrowth is characterized roentgenologically by the appearance, under the use of a soft tube, of a lesser gray shadow filling the cardiophrenic notch at the apex and tailing off from the pericardium overlying the left inferior border and apex to the upper surface of the diaphragm. It is roughly triangular in most instances. A similar gray shadow may occur at the corresponding angle on the right side." The author presents briefly the roentgenological findings in a case of "chronic universal enlargement of a heart primarily of the sthenic type." "A 'fatty tail' indicating some degree of 'fatty overgrowth' ('fatty infiltration,' 'fatty heart'). It will be noted that this condition obliterates both right and left inferior angles."

We failed to find other reports in the literature of shadows in the right cardiophrenic angle caused by an extrapericardial accumulation of fat tissue. On account of the apparent rarity of such observations we wish to present the following case:

CASE REPORT

A man, aged forty, came to autopsy following five days of profound alcoholic intoxication. His previous history is not pertinent beyond the fact that during the last year of his life he had had repeated severe asthmatic attacks, and that preceding his fatal illness his blood pressure was 150/110. His electrocardiogram at that time showed flattened T-waves in lead one.

A roentgenogram of the chest, taken four and a half months before death, was interpreted as follows: The thorax is of pyknic type and emphysematous; the two diphragmatic leaves are slightly low in position and are at the same level. The costophrenic angles are clear. Overlapping the cardiophrenic angles there are approximately triangular soft shadows (Fig. 1). They are less dense than the heart shadow. The paracardial shadow is more marked along the cardiac apex than at the right side (Figs. 2 and 3); it extends from the midportion of the left lower cardiac arch downward to the dia phragmatic dome. The lesser density of the paracardial shadows produces the appearance of a nuclear cardiac shadow ("Kernschatten"); a similar appearance was described by Fleischner in cases of posterior pleuro-mediastinitis. The heart shadow presents no appreciable changes in size and shape from the normal. There is some increase in the density and size of the hilar markings. The lung fields are well aerated and show no evidence of pulmonary or pleural involvement. Figures 2 and 3 show the cardiophrenic regions in original size to demonstrate in detail the character, size and relative density of the paracardial shadows.

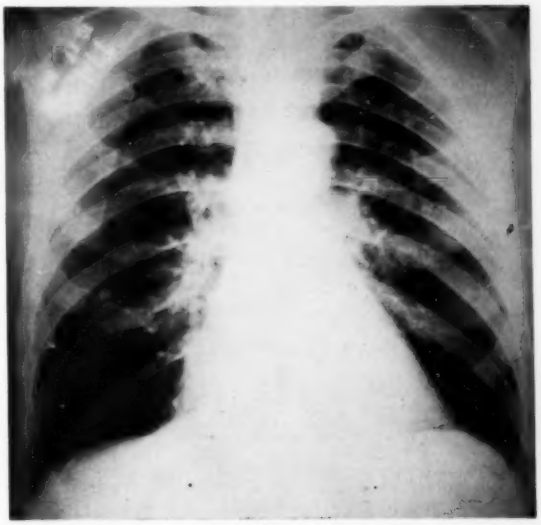

Fig. 1. Roentgenogram taken four and a half months before death. Note the soft paracardial shadows at the apex and the right cardiophrenic angle.

FIG. 2. Copy in original size of apical cardiac region to show the soft paracardial shadow extending downward from the midportion of the left lower cardiac arch; the cardiac apex is visualized as nuclear density, as shown by arrows.

Autopsy Findings. The pathologico-anatomical diagnosis was as follows: (1) massive cerebral and meningeal edema (alcoholic?); (2) eccentric hypertrophy of the heart; (3) degenerative changes of the myocardium; (4) diffuse nephritis with marked nephrotic changes; (5) pulmonary edema; (6) epicardial edema; (7) moderate generalized arteriosclerosis; (8) chronic passive congestion of liver, spleen and kidneys; (9) chronic purulent bronchitis and peribronchitis; (10) chronic (alcoholic) gastritis; (11) chronic atrophic colitis; (12) massive fat infiltration of liver; (13) marked obesity with massive fat deposits around the pericardium and around the kidneys. The only organ pertinent to this report is the heart.

The pericardial sac contains a normal amount of clear fluid. There is a moderate amount of epicardial fat tissue which is slightly edematous. The total shape of the heart is globular. The myocardium measures up to 18 mm. in the left and up to 11 mm. in the right ventricle. Both auricles are markedly dilated. The valves are normal. The coronary arteries show slight endothelial lipoid deposits without narrowing of their lumina.

The pericardium is flanked on both sides by large masses of lobulated yellow fat tissue. They reach from the level of the aortic arch to the dome of each diaphragmatic leaf. The total amount of this epipericardial fat tissue is at least equal to the volume of two fists. There is practically no fat tissue on the posterior surface of the pericardium and only a moderate amount on the anterior surface. The most massive accumulations of fat tissue are on the lateral surfaces of the pericardium, and particularly in the regions of the cardiophrenic angles. Figure 4 shows the pericardium with the fat appendages. The heart has been removed from the pericardial sac, the latter is stuffed with cotton and sutured. The little black dots are the heads of pins that have been inserted along

FIG. 3. Copy in original size of right cardiophrenic region to show the soft paracardial density overlapped by pulmonary markings and in the epiphrenic area by a portion of a rib. Arrows point to the shadow cast by the fat body; asterisks indicate the costal shadow.

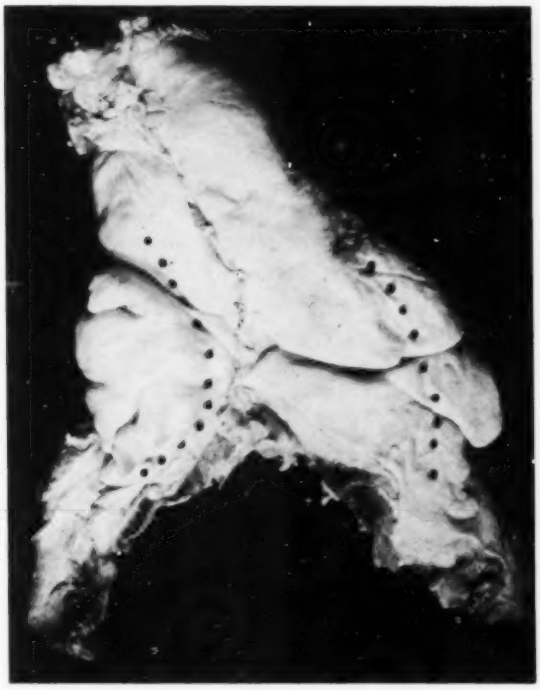

Fig. 4. Anterior view of the pericardium with fat bodies along the lateral borders. Pinheads indicate the lateral borders of the pericardial sac.

the lateral pericardial surfaces so as to indicate the true heart borders. It is seen from this photograph that the right pericardial-diaphragmatic angle is filled with large masses of fat tissue which reach here an anteroposterior thickness of 2.7 cm. The lateral margin of this fat body reaches well over the tendinous portion of the right diaphragm, and the distance from the pericardium to the lateral margin of the fat body is 4.0 cm. The fat body on the left margin of the pericardium is up to 1.5 cm. in anteroposterior thickness and it protrudes 2.5 cm. over the left border of the pericardium.

In view of the roentgenological shadows in the pericardial-diaphragmatic angles, a careful anatomical search was made for lesions in these regions. No changes were found in the lungs that could produce these shadows, and, particularly, there were no pleural or pericardial adhesions or fibrosis in these regions.

It seems justifiable, therefore, to assume that the epipericardial fat bodies produced the roentgenographic densities shown in Figures 1, 2 and 3. It is of importance to know that shadows in the cardiophrenic angles, such as shown in Figure 1, can be produced by extrapericardial fat tissue and that they are not necessarily caused by pathologically significant processes in these regions.

SUMMARY

The roentgenological and anatomical findings are presented of a case in which shadows in both cardiophrenic angles were entirely due to massive accumulations of extrapericardial fat tissue. The differential diagnostic significance of this finding is discussed.

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CONGENITAL CYSTS OF THE LUNGS*

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CYSTIC malformations of the lungs were first described by Fontanus[4] in 1638. He performed an autopsy on a three months old child who had died in the course of an attack of cyanosis and whose lungs were replaced by air blebs communicating with the bronchi. Until lately, the disease has been considered a great rarity. Koontz,[6] reviewing the literature in 1925, found only 108 cases reported. Croswell and King[1] found only 12 additional cases reported in the American literature between 1925 and 1933. More recently the disease has been observed by numerous authors, and the recent literature shows that the disease is not as uncommon as previously believed.

Its roentgenological appearance is more characteristic than the clinical symptomatology. One reason that only few cases were known until recently is that many cases were misinterpreted roentgenologically. In adults, in whom the cysts are often multiple in type, a diagnosis of ulcerative tuberculosis was often made and the patients subjected to unnecessary hospitalization. In children, in whom the solitary cyst is more common, a diagnosis of pneumothorax or emphysema secondary to a nonopaque foreign body was made, and the true nature of the disease was revealed only at autopsy or at a later review of the films.

According to Müller[8] the congenital nature of a disease is proved by finding it in fetuses and stillborn infants. Grawitz[5] divides the lesions into two groups. The first is called bronchiectasis universalis. In this form a whole or a part of one lobe, or even a whole lung, may show various degrees of cystic formation ranging from miliary cysts scattered through otherwise normal parenchyma to conversion of a lobe or of a whole lung into large multilocular or unilocular cystic sacs. The second group, called by Grawitz bronchiectasis telangiectatica, consists of a partial, circumscribed cystic enlargement of a bronchus section which may or may not communicate with the rest of the bronchi. The former group is generally known as diffuse or multiple and the latter as solitary or air cyst.

Histologically, according to Müller, the cysts imitate more or less the structure of the bronchi and bronchioli. The thin-walled small cysts are lined either by cuboidal or cylindrical epithelium or ciliated epithelium. The larger thick-walled cysts show the structure of the larger bronchi, being lined by a multiple layer of cylindrical epithelium, which may be ciliated. On the outside there is a fibrous tissue, containing blood vessels, elastic fibers and muscle bundles.

Most of the cysts contain air, but according to Miller[7] there is likely to be a small amount of mucus and cellular material in the cavities. At times they have a fluid content and certain of the large sac-like cysts have been said to contain large amounts.

As to the etiology, numerous theories are advanced, most of which postulate defect in the development of the bronchi of embryonal origin. Virchow[15] suggested the possibility of the cyst representing lymphangiectasis. Grawitz[5] thought that a hydropic collection is the cause of the bronchial dilatation. Parmelee and Apfelbach[11] believed that the developmental error consists of an interference in the development of alveolar tissue, which leaves the bronchi unsupported and consequently causes them to dilate. According to them, an originally small congenital bronchiectatic cavity grows in size as the child breathes, producing a one way valve mechanism allowing the air to enter the sac and inflate

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it, but not allowing a corresponding deflation. As the sac grows the bronchial radical is more compressed and a vicious circle ensues. This is an acceptable explanation for the giant, solitary cysts, but leaves the origin of multiple cysts unexplained.

Stoerk[13] called the disease cystic fetal bronchial adenoma, as he found in a newborn child's right pleural cavity an oval tumor the size of a hen's egg which displaced the upper lobe upward and posteriorly, the lower lobe downward and the middle lobe backward. The tumor measured 6 cm. in length and 4 cm. in width and on section contained cavities each measuring between 1 and 6 mm. in diameter. The lumina of the cavities contained a slight amount of clear fluid. The tumor could not be well separated from the compressed middle lobe. Microscopic section showed alveolus-like cavities of different sizes, separated by septa, lined with a single layer of cuboidal or flat cylindrical epithelium. In Wechsberg's case[17] there was a tumor in the left pleural sac which was attached to the pleural covering of the esophagus merely by a fibrovascular pedicle. It contained numerous cysts filled with clear fluid and lined with cuboidal or columnar epithelium. Wechsberg believed that this tumor arose from an accessory lung anlage arising separately from the esophagus with secondary obliteration of the connecting canal. Pappenheimer[10] suggested the possibility of the process being the end-result of fetal inflammation with inflammatory stenosis or atresia of bronchi and bronchiectatic dilatation of the distal portions from stagnation of secretion.

There is no typical clinical symptomatology. Many of the cases are clinically silent, but in others there is a history of repeated attacks of bronchitis, associated with cough and expectoration, rarely with slight elevation of temperature. In children, where the solitary giant type of cysts is more common, the symptoms may be alarming, consisting of unexplained attacks of dyspnea, cyanosis, at times associated with shock, although surprisingly large cysts may not cause any clinical symptoms (see Case IV).

CASE REPORTS

Case 1. A white male, aged twenty-three, was admitted to Cleveland City Hospital on August 25, 1933, and died five days later. The patient had been in the Warrensville Sanatorium for two years, sixteen years previously, and had had a tuberculous kidney removed at another hospital nine years before admission.

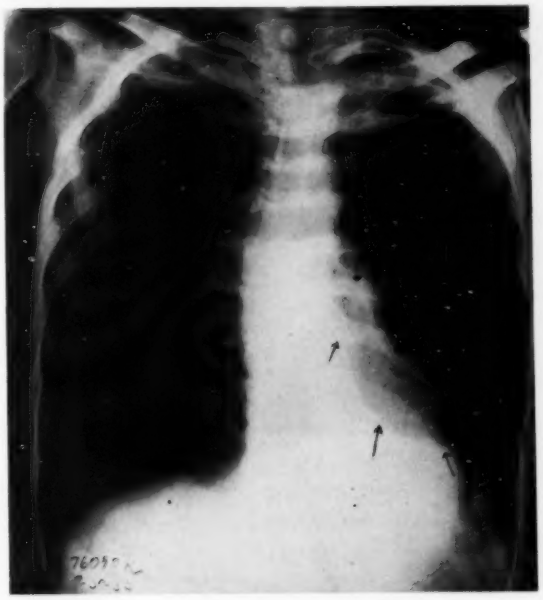

Fig. 1. Case 1. Chest roentgenogram showing numerous ring-shaped shadows throughout the left base, overlying the heart shadow, due to proved congenital cysts of the lung. There is a cloudiness in the left apex, due to a tuberculous infection.

He entered City Hospital with uremia, the blood urea nitrogen being 203 mg. per 100 c.c. and the blood creatinine 9.2 mg. per 100 c.c. The red blood cell count was 4,340,000 and the white blood cell count was 10,240. Both testes were enlarged and the epididymes palpable and tender. The prostate was large, firm, irregular and tender. On physical examination no abnormalities could be demonstrated in the lungs.

The clinical diagnosis of tuberculosis of the remaining right kidney, the prostate, bladder and the epididymes was made.

A routine chest film was taken with the patient in recumbent position on the day of death. This showed a slight haziness in the left apex, indicating a minimum degree of fibroid

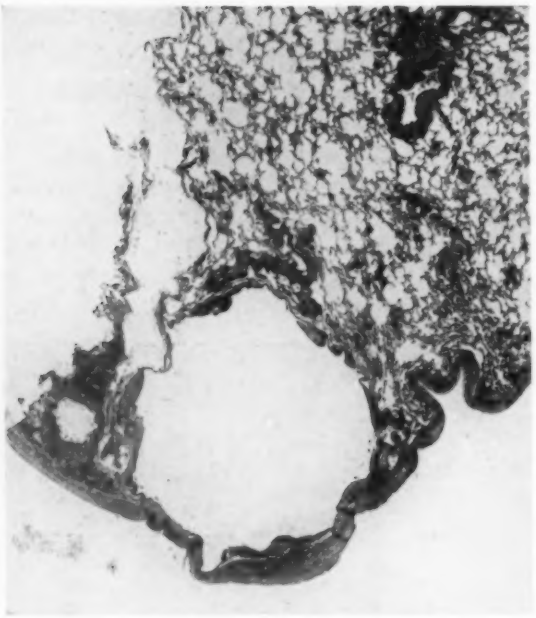

FIG. 2. Case I. Photomicrograph showing a congenital cyst. The wall of the cyst is composed of fibrous, connective tissue, which is covered by a single layer of flat endothelial cells. Hematoxylin and eosin stain ×12.

tuberculosis. The roentgenogram (Fig. 1) also showed numerous ring-shaped shadows of increased density throughout the medial portion of the left base, overlying the region of the left ventricle. These shadows measured between 0.5 and 5 cm. in diameter and were surrounded by apparently normal lung tissue, so that the roentgenological appearance suggested either congenital cysts or emphysematous blebs.

At the post-mortem examination performed by Dr. Herbert Reichle, the left lower lobe was found to be of increased consistency throughout, but within it large cyst-like spaces were palpable. Upon section very little lung tissue was found. The majority of the cut surfaces were composed of thick-walled cystic structures which varied in size between 0.5 and 4.5 cm. in diameter. Many of these were lobulated and intercommunicated with adjoining cavities. The lung tissue lying between such cavities was firm, fibrous in appearance. The cavities themselves were smoothly lined and did not contain exudate. The section through the major bronchus to the left lower lobe revealed the fact that many, if not all, of these cavities communicated with the bronchi, which ended imperceptibly in the cystic dilatation.

The microscopic section (Fig. 2) showed the dilated cystic spaces described grossly. The bronchial epithelium was normal in appearance, and the bronchial walls presented only a slight lymphocytic infiltration. The picture was not that of bronchiectasis. The surrounding lung tissue was atelectatic and fibrotic and showed a slight passive hyperemia. The lining cells of the alveoli were cuboidal in type. The cystic spaces were lined with cuboidal epithelium. The bronchi showed an acute purulent bronchitis. The arteries and arterioles were not remarkable.

The pathologic diagnosis of congenital cystic lung of the left lower lobe and chronic fibroid tuberculosis of the left apex was made.

CASE II. A white female, aged thirty-four, was admitted to City Hospital on December 21, 1933, complaining of generalized weakness, indigestion and joint pain.

About one and one-half years before, the patient's knees began to get stiff and painful with limitation of motion. Next her wrists, elbows and shoulders became involved so that she had been unable to walk without help for the preceding five months.

The blood Wassermann test was four plus. The red blood cell count on December 22, 1933, was 4,490,000; the white blood cell count was

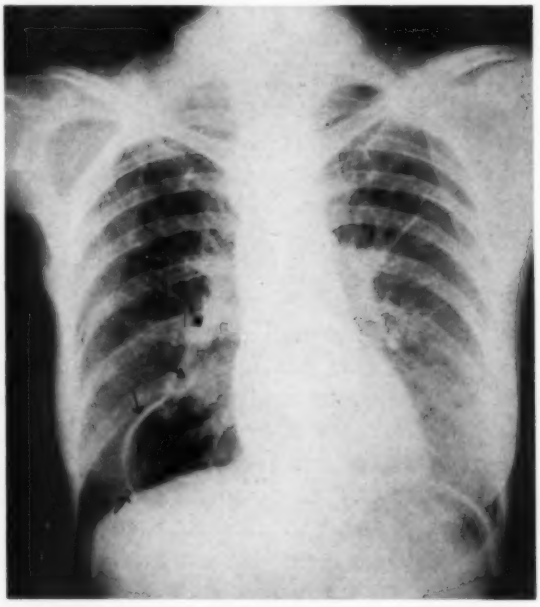

FIG. 3. Case II. Anteroposterior roentgenogram showing a moderate fibrosis in the right lung field with a large air cyst in the medial portion of the right base and a smaller one above it.

15,000. The temperature varied between 37.0 and 38.0°C.

The clinical diagnosis of atrophic arthritis was made and in searching for possible foci of infection, a routine chest film was taken. It showed numerous dense, fibrous strands throughout the entire right lung and a cloudiness in the right apex, which was interpreted as being due to a slight, generalized fibrosis. In addition, a circular, linear shadow of increased density was noticed in the medial portion of the right base which surrounded a circular area of diminished density measuring about 6 cm. in diameter. A similar, but smaller structure was seen a little higher, near the lower pole of the right hilus, partly obliterated by the hilus. In the lateral view both shadows appeared to be situated in the right lower lobe (Figs. 3 and 4). There was no evidence of any inflammatory reaction around these structures and a subsequent roentgenogram after barium meal revealed the fact that none of the structures communicated with the esophagus, stomach or colon. In view of negative clinical history, i.e., lack of cough, expectoration and pain in chest, the roentgen diagnosis of congenital air cysts of the right lower lobe was made.

A subsequent examination, after lipiodol injection into the right main bronchus, showed all the bronchi of the middle and lower lobes to be normal in distribution and size. No lipiodol entered any of the cysts, although the presence of communication is indicated by the air content of the cysts at repeated examinations. Apparently the cysts are embedded in the midst of normal lung tissue.

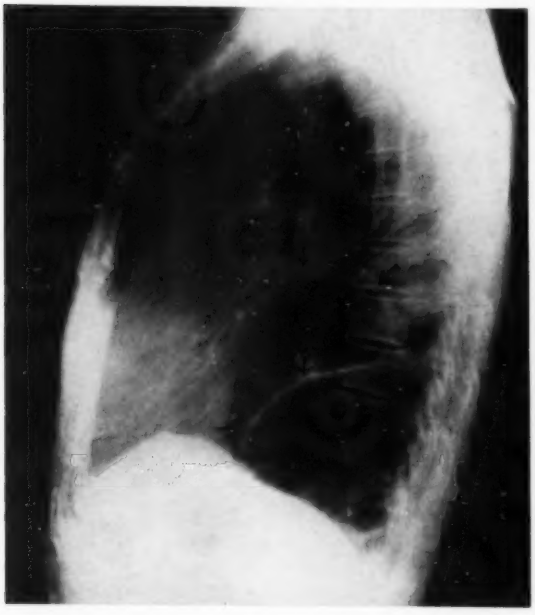

Fig. 4. Case II. Right lateral view showing both cysts to be situated in the right lower lobe.

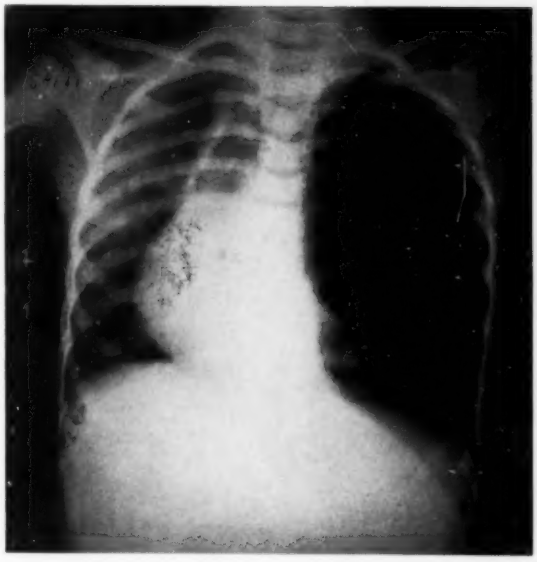

Fig. 5. Case III. Roentgenogram showing a giant air cyst involving the entire left lung, extending to the right in the region of the upper anterior mediastinum, causing a herniation of the mediastinum. Heart markedly displaced to the right.

Case III. A white female, aged six, was admitted to Cleveland City Hospital on April 2, 1931, on the suggestion of her school physician who on routine examination discovered a pneumothorax on the left side. The patient's clinical history was essentially negative. She had had cough only rarely, at times occasional colds, but never expectoration. There was no history of shortness of breath, pain in the chest or night sweats.

On physical examination the chest was found symmetrical and the costal flare symmetrical. The left lung was tympanitic and no breath sounds could be heard over it except posteriorly along the spine. The percussion and auscultation sounds were normal on the right side.

The clinical diagnosis of spontaneous pneumothorax was made. Roentgenogram taken the day of admission showed the intercostal spaces on the left side to be very wide and the entire left hemithorax to show increased air content. The normal lung markings throughout the left were absent with the exception of the

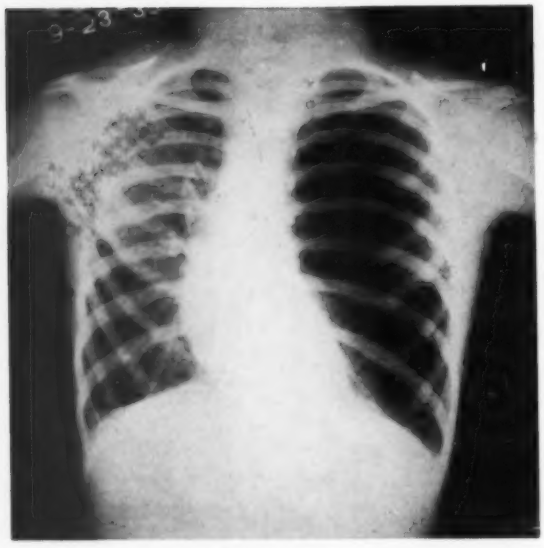

Fig. 6. Case III. Roentgenogram taken twenty-nine months later showing but little change in the appearance of the cyst. The mediastinal hernia has receded and the right displacement of the heart is less marked.

medial portion of the base where normal appearing lung tissue could be seen over a triangular area which was irregularly demarcated. Under the roentgenoscope the heart moved over to the right during inspiration, and moved back slightly to the left on expiration. The outlines of a mediastinal hernia could be seen on the right extending about 5 cm. to the right from the upper dorsal vertebrae (Fig. 5).

The roentgen examination appeared to confirm the clinical diagnosis of spontaneous pneumothorax. The tuberculin test was found to be negative in 1:100 dilution.

On reading Croswell and King's publication[1] subsequently the similarity of the roentgenologic appearance between their case and this case was noted. A re-examination on September 28, 1933, showed that the roentgenological appearance (Fig. 6) was identical with the one obtained twenty-nine months before, with the exception that the mediastinal hernia on the right had receded. Lipiodol injection into the left main bronchus was refused by the parents because the child was symptomless.

Nevertheless, the clinical picture and roentgenological findings indicate that the condition is a giant air cyst involving almost the entire left lung and extending to the right in the upper mediastinum. There was no history of sudden onset as in spontaneous pneumothorax, nor did the roentgen examination show an appreciable change in twenty-nine months. The remarkable feature of this case is that despite the absence of more than half of the aerating surface (on account of the heart occupying a portion of the right hemithorax) the patient had had no subjective symptoms.

Case IV. A colored male, aged twenty-eight, was admitted to the Out Patient Department of City Hospital complaining of gnawing sensation in the epigastrium of three months' duration during and immediately after meals, regardless of the type of food.

The patient had always been in relatively good health, although subject to colds. He had had influenza in 1918 and pneumonia as a child.

The physical examination showed a well-developed colored male. The chest was symmetrical and normal on percussion. Auscultation revealed only a few questionable râles in the lower right anterior chest.

The patient was referred for a roentgenological examination of the gastrointestinal tract, which was found to be normal in appearance.

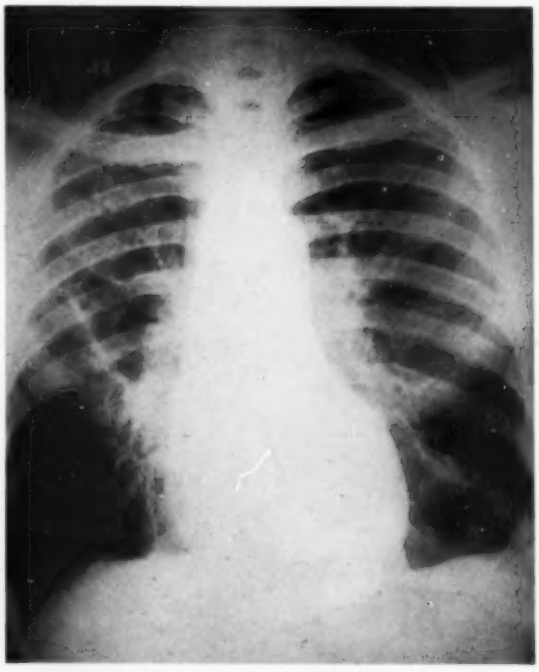

Fig. 7. Case IV. Anteroposterior view showing numerous irregular ring-shaped shadows extending from the right hilus toward the apex, due to congenital air cysts. Note lack of inflammatory changes around the cysts.

During the screen examination a lesion was found in the right chest. It consisted of numerous, rather irregularly defined ring-shaped shadows of increased density, extending from the hilus toward the apex. The largest shadow measured about 6 cm. in diameter. Others were smaller, the smallest one measuring about 3 mm. in diameter. There was no evidence of infiltrative areas around them and the cavity-like shadows showed no fluid. The lateral view demonstrated that the lesion was situated in the anterior half of the right upper lobe (Figs. 7 and 8).

Upon questioning, the patient admitted that on account of frequent colds he had had a previous roentgenogram of the chest taken elsewhere one and a half years prior to the present examination, at which time the diagnosis of ulcerative pulmonary tuberculosis was made from the roentgenograms. Repeated sputum examinations at that time were negative for tubercle bacilli. Upon inspection of the old films it was found that the appearance of the shadows had remained unchanged during the year and a half interval.

The lack of infiltrative areas around the "cavities," the unchanged appearance of the lungs during the year and a half, and the relatively scant clinical symptomatology are all in favor of a congenital cystic disease.

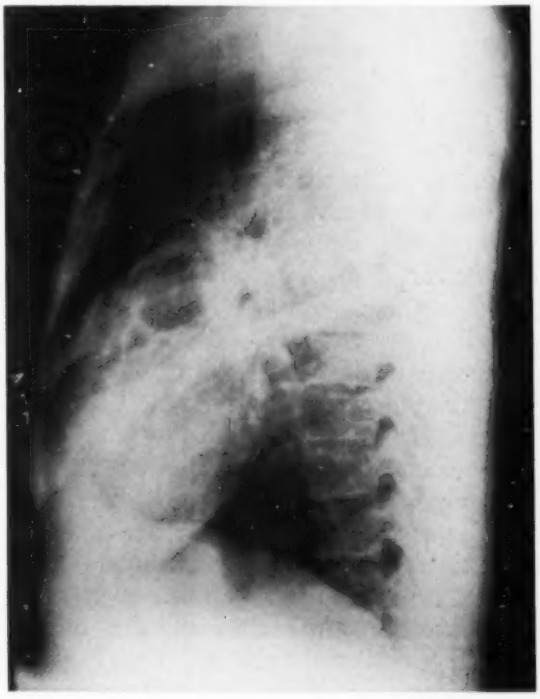

Fig. 8. Case iv. Right lateral view showing the cysts to be situated in the anterior lower portion of the right upper lobe.

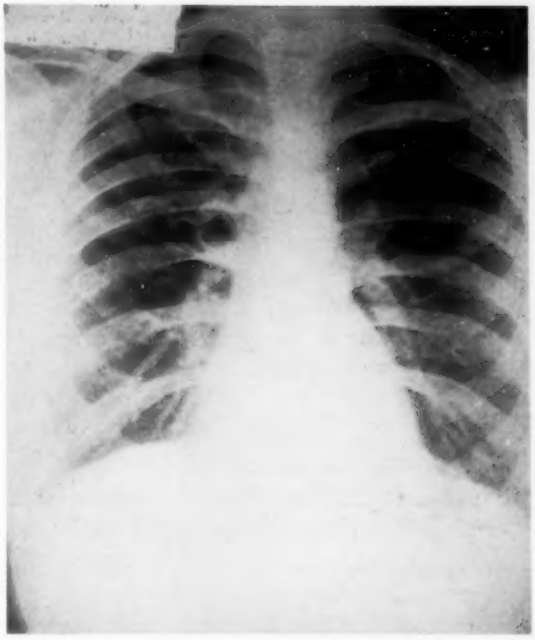

Fig. 9. Case v. Roentgenogram showing numerous circular and irregular curved lines of increased density in the medial portion of the right subapical region, due to congenital air cysts. A chest film taken four years before showed a similar appearance of the lungs.

Case v. Mrs. R. W., white, aged thirty, was referred to Drs. M. August and I. E. Yoelson. The patient had influenza during the last week of December, 1934 and while convalescing from it, developed a hemoptysis on January 4, 1935. The hemoptysis followed a mild attack of cough and consisted of about two tablespoonfuls of red blood. It subsided immediately and on clinical examination soon afterward only a few râles could be heard in the right apex. There was no elevation of temperature, nor expectoration. The blood count was normal.

Roentgenologic examination of the chest on January 8, revealed numerous, irregular and circular striped shadows in the basal portion of the right upper lobe (Fig. 9). These shadows were not surrounded by mottling and the remaining parts of the lungs were clear. A tentative diagnosis of congenital cystic lung disease of the right upper lobe was made and the hemoptysis was explained by a probable rupture of one of the cysts.

Upon further questioning, the patient revealed the fact that four years ago she had had a roentgen examination because her physician at that time discovered a few râles in her right lung during a routine chest examination. These films were forwarded to Drs. August and Yoelson and the same type of shadows was found in the right upper lobe as seen on the present films. The unchanged appearance of the lungs confirmed the previously made diagnosis of multiple, small congenital cysts. Lipiodol was injected into the right upper lobe at this time, but the contrast material failed to enter any of the cavities. The bronchi throughout the right upper lobe were of normal size and distribution.

DIAGNOSIS

The roentgenological appearance of congenital cysts of the lungs is very variable and dependent on the size and distribution of the cysts.

The smaller sized solitary cysts are represented by thin-walled shadows of increased density, with a clearcut outline and with no evidence of peripheral inflammatory reaction changes. An unusual roentgenological appearance of small-sized generalized cysts in the lungs is reported by Stewart, Kennedy and James.[14] The patient, a woman, aged fifty-four, showed a generalized involvement of both lungs, which appeared as though thickly sprinkled with small lumps of raw cotton. The bronchial tree was made out with difficulty and the appearance was considered that of a generalized tuberculosis process. A roentgen examination elsewhere reported the presence of a tuberculous infection involving both lungs with cavities at the right apex and numerous exudative foci throughout the rest of the lungs. At autopsy numerous nodules were palpable underneath the pleura, which on section turned out to be due to thick-walled cavities, measuring up to 15 mm. in diameter. Microscopically, they were found to represent various sized distended bronchi, surrounded by airless, vascular connective tissue.

The walls of the giant cysts are not as clearly defined as those of the smaller ones. Most commonly they are not detectable at all and the appearance is that of an overpressure pneumothorax with a displacement of the heart and trachea to the opposite side. The lung markings throughout the entire hemithorax may be completely missing, or, as in our Case IV, only few normal markings are present throughout some circumscribed portion of the lung with an absence of the markings throughout the rest.

In some other giant cysts when there is a larger amount of normal lung tissue in the peripheral parts, the markings can be recognized throughout but the wall of the cyst remains invisible, giving the roentgenological appearance of only a marked increase of the air content of the lung with displacement of the heart and trachea, leading to a diagnosis of an obstructive emphysema due to a nonopaque foreign body (Nelson's Case).[9]

The multilocular cysts show a honeycombed network with larger and smaller hexagonal, oval and circular cells of diminished density which most commonly contain air, but at times fluid levels. The partitions between these cells are thin-walled and sharply defined, more so than one sees in cases of acquired bronchiectasis. In uncomplicated cases there is no evidence of reactive inflammatory tissue formation often seen around bronchiectatic cavities and always around tuberculous cavities. This is a very important differential diagnostic sign.

Owing to the lack of inflammatory changes, shrinking of the lungs is absent. The hila are not dislocated, the heart and trachea are in the midline and the hemithoraces are symmetrical in size, without any evidence of narrowing of the intercostal spaces on the diseased side.

At times congenital cysts may not cast any detectable shadow on the roentgenogram because the septa of the honeycombed or ring-shaped shadows are too thin to become visualized or because involved lung parts are obscured by overlying organs.

From a differential standpoint, in cases

of solitary cysts at the basal portion of the lungs, herniation of the stomach or intestinal loop through the diaphragm can be ruled out by a barium meal or enema. A solitary echinococcus cyst may be of the size and shape of a congenital cyst, but the former usually contains fluid whereas the latter only rarely does.

In cases of giant air cysts, the most commonly made mistake is that of a diagnosis of spontaneous pneumothorax. In infants the clinical history will be of no avail; however, in children and adults the description of the acute, usually painful onset that introduces spontaneous pneumothorax will be of great help. Furthermore, in pneumothoraces the outlines of the collapsed lung are distinguishable, whereas in large air cysts, no demarcation of the lung can be detected. Then a spontaneous pneumothorax never remains as stationary as an air cyst, and repeated examinations show the gradual absorption of air. Furthermore, in a spontaneous pneumothorax there is likely to be fluid in the pleural cavity.

The differentiation between an obstructive emphysema and an air cyst without distinguishable wall will be difficult mainly in infants.

A most important differential diagnosis is that between a multilocular air cyst and ulcerative tuberculosis. In tuberculosis, whenever multiple ulcerations are present there is usually a considerable amount of striped or mottled inflammatory change around the diseased area, with evidence of shrinking, i.e., displacement of heart, trachea, hilus, and retraction of the hemithorax. The patient's relatively good physical condition in the presence of an ulcerative lesion should also prevent one from making the diagnosis of ulcerative tuberculosis, mainly if repeated sputum examination is found to be negative for tubercle bacilli.

It is well to remember, that hemoptysis may occur in congenital cystic disease also, most likely caused by the rupture of the wall of an overdistended cyst.

The differentiation between acquired bronchiectasis and congenital multiple cyst is not difficult, provided the cysts are not infected. The cyst walls are thinner than the walls of acquired ectatic bronchi, and the signs of shrinking that are commonly found in bronchiectasis are missing in congenital cysts. If the cysts become infected, contain large amounts of fluid and are surrounded by inflammatory changes, then, of course, the roentgenological differential diagnosis becomes impossible.

TREATMENT

According to Eloesser[3] treatment is indicated only when the cystic anomaly causes symptoms, due to pressure on the bronchi and great blood vessels, when an attempt of removal is in order.

According to Debré and Blinder[2] bronchoscopic examination or exploratory tapping in a case of large solitary cyst is dangerous because grave accidents may follow the investigation. In Swanson's case the bronchoscopic examination was followed by the child's death forty hours later. In Volmer's case[16] the cyst was punctured, air aspirated from it and the child went into shock immediately which, however, was not fatal. Parmelee and Apfelbach[11] report a case of a seventeen-month-old girl in whom pneumothorax was diagnosed, a needle introduced into the thoracic cavity and air aspirated. She collapsed immediately, was revived with difficulty, and died about sixteen days later.

However, exploratory tapping is not always followed by such disastrous results. Croswell and King's patient[1] with a giant solitary cyst of the left lung improved remarkably after the introduction of a one way valve mechanism for aspiration of air. The cyst collapsed to about one-fourth of its original size and the patient's clinical symptoms disappeared.

In adults the cysts cause symptoms when infection supervenes presenting the clinical picture of a widespread bronchiectasis with cough and copious purulent sputum, dyspnea, fever and sweats. These cases should

be treated as any other case of bronchiectasis.

Large multilocular cysts if infected should be widely opened and drained.

Eloesser[3] suggests thoracoplasty in certain cases of congenital cystic lungs, but so far according to our knowledge, this method of treatment has not been attempted.

CONCLUSIONS

1. Congenital air cysts of the lungs are more common than previously thought.

2. The roentgenological appearance is variable, depending on the number and size of the cysts.

3. Giant air cysts commonly produce a pneumothorax-like appearance, and if a patient presents the clinical and roentgenological symptoms of spontaneous pneumothorax without a history of acute onset, the possibility of a giant air cyst should be considered. In rare instances a giant air cyst may produce the clinical and roentgenological symptomatology of an obstructive emphysema.

4. Smaller cysts, if numerous, produce honeycombed shadows which, at times, mainly if they are situated in the upper lobes, simulate an ulcerative tuberculosis and at other times an extensive bronchiectasis. However, in cases of cysts, there is no evidence of inflammatory changes around the honeycombed shadows, nor of retractive changes in the lung fields, hila or thoracic cage, as in inflammatory conditions.

5. Minute, disseminated air cysts may stimulate the roentgen appearance of a disseminated tuberculous process or of a fungus infection.

6. At times, smaller congenital air cysts cannot be detected in the roentgenogram, due to thinness of their walls, or because they are obscured by overlying organs.

7. The extent of the roentgenological changes as compared with the paucity of the clinical symptomatology indicates congenital anomaly.

8. Most of the cysts contain air, but there is likely to be a small amount of mucus or cellular material in the cavities. At times they may contain large amounts of fluid.

9. Hemoptysis may occur in congenital cystic lung disease.

10. The treatment of congenital cysts should be conservative as long as the patient is symptomless. No giant air cyst should be tapped unless it interferes with respiration, because tapping of a giant air cyst may be followed by shock and death.

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SIMPLE CYST OF THE PLEURA

REPORT OF A CASE*

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NEITHER the standard textbooks and comprehensive handbooks of pathology (Karsner,[4] MacCallum,[6] Kaufmann[5]), nor the literature of roentgenology disclose any mention of a pleural cyst such as is reported herewith. The cyst had a thin, poorly vascularized, scantily cellular fibrous wall which showed mild chronic inflammation. It contained clear canary-yellow colored fluid of low specific gravity and was lined by a single layer of flattened cells of endothelial type. The term "simple cyst" is applied in contradistinction to other types.

The case is reported because of its diagnostic difficulties and because of its rarity.

A white male, aged forty, was admitted to the Cleveland City Hospital September 13, 1932, complaining of pain in his stomach for the preceding one and one-half years. Five months before admission this pain had become almost continuous and the patient began vomiting once or twice a day. He was operated on one month before admission, at Lutheran Hospital of Cleveland, at which time an obstructing tumor of the first portion of the duodenum was found, and a posterior gastroenterostomy was performed. Soon after the operation jaudice set in and the pain had not decreased.

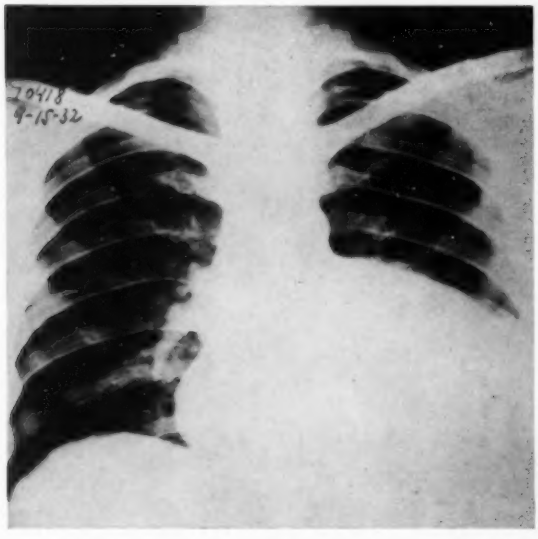

FIG. 1. Anteroposterior view showing a semicircular area of increased density at the left base due to a simple cyst of the pleura, extending from the hilus to the lateral chest wall and obliterating the heart shadow.

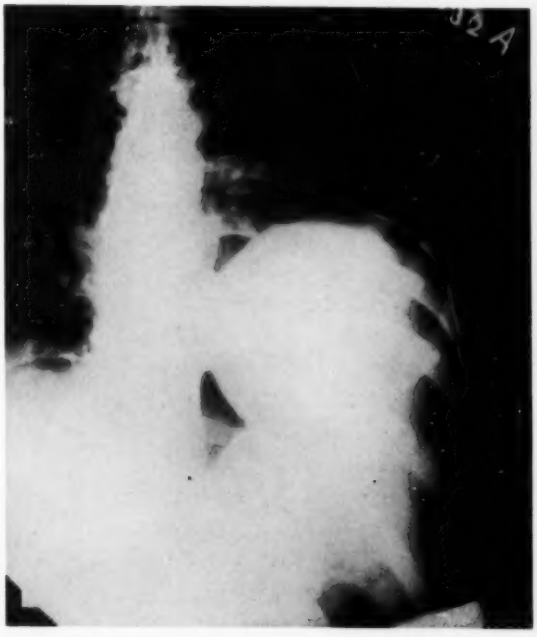

FIG. 2. Heavy exposure film which shows the shadow to be circular and sharply defined, measuring about 15 cm. in diameter.

On physical examination an area of dullness was found in the posterior lower portion of the left chest and no breath sounds were present over the same area. The patient had no difficulty in respiration nor was there any history of cough, expectoration or pain in the chest. Roentgenograms of the chest revealed a semicircular shadow of increased density at the left base, the upper border of which was sharply defined and extended from the heart to the lat-

* From the Roentgenological Service of the University and Cleveland City Hospitals and Department of Pathology of Cleveland City Hospital and Western Reserve University.

FIG. 3. Lateral view showing the shadow to be situated in the posterior two-thirds of the left base.

eral chest wall, its lower border obliterating the diaphragm (Fig. 1). On a heavy exposure film (Fig. 2) the shadow appeared to be circular and sharply defined, measuring about 15 cm. in diameter. In the lateral view (Fig. 3) the shadow was seen to be situated in the posterior two-thirds of the left base. The roentgenological diagnosis of an echinococcus cyst was suggested. The fact that the patient came to the United States from one of the Balkan States appeared to favor this diagnosis. However, the injection of 0.1 c.c. of echinococcus vaccine with 0.5 per cent phenol intradermically failed to yield a positive reaction.

On September 17, 1932, an exploratory puncture of the cyst was performed; 1,000 c.c. of canary-yellow clear fluid was withdrawn from the cyst and 200 c.c of air was injected. The specific gravity of the fluid was 1008 and the microscopical study showed only a few leukocytes and red blood cells. There were no echinococcus hooklets in the fluid. A film taken subsequent to the tapping (Fig. 4) showed the cyst to be collapsed to about one-third of its original size. There was some air in its upper part and fluid at its base.

At post-mortem examination, performed by Dr. D. Seecof, a cystic structure measuring about 15×10 cm. in diameter was found in the left thoracic cavity, arising from the superior surface of the diaphragm in the posterior pericardial angle. The cyst consisted of a thin-walled, fibrous sac, slightly trabeculated by thin fibrous septa, containing about 25 c.c. of blood-tinged fluid.

On microscopic examination the wall of the cyst was composed of a scantily cellular fibrous structure, separated into two distinct layers by a central zone, in which there was a moderate number of blood vessels and scattered foci of lymphocytic accumulation. The free surface of both layers was in places lined by flattened endothelial cells.

The obstructing tumor in the region of the second portion of the duodenum was found to be a primary carcinoma of the duodenum. Careful search failed to reveal tuberculosis in any of the organs.

DISCUSSION

It is of interest to consider the possible methods of formation of such simple cysts in the pleura. In this case at post-mortem examination it was thought to be of congenital origin because of its thin wall and location. The low grade inflammatory reaction in the wall was interpreted as secondary due to irritation caused by respiratory movements. The possibility of inflammatory origin was also considered and could not be excluded definitively.

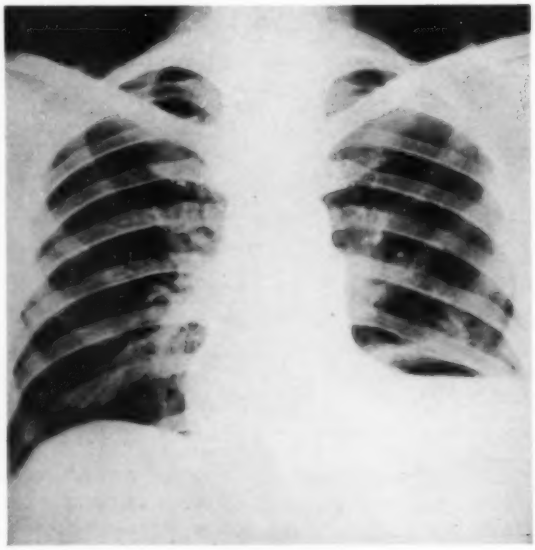

FIG. 4. Anteroposterior view taken after removal of 1,000 c.c. of fluid showing the collapsed pleural cyst which still contains some fluid.

It is possible that a simple thin-walled cyst could represent a localized or encapsulated hydrothorax, particularly in the region of the cardiophrenic angle. A chronically inflamed and dilated pleural lymphatic vessel could also produce such a picture. It is also possible that injury or inflammation could invaginate a few cells of either the visceral or parietal pleura which by multiplication and secretion might set up a cystic inflammatory structure not unlike the method which is thought to be responsible for the formation of serous cysts in the parovarium and over the surface of the ovaries.

The possible origins and modes of formation of congenital cystic structures of the pleura or those found in the pleural cavity are all open to speculation and the adduction of positive proof for any given mode or site of origin is difficult.

Case reports in the literature of congenital cysts of the pleura number approximately sixteen. Staehelin-Burckhardt[8] in 1909 compiled 13 instances, including his own observations, and from then on until the present time we have been able to collect only 3 additional cases.[1,2,7]

According to Fischer[2] the congenital cysts are due to disturbances in development at about the sixteenth week of embryonal life at the time when the trachea and esophagus cease to communicate. Microscopically some of them show the typical picture of an intestinal segment with a mucosa, submucosa, circular and longitudinal muscle fibers, a serosa and well-differentiated Auerbach's plexus ganglion cells. These apparently represent detachments from the alimentary segment. In others, where the detachments originate from the trachea or lung anlage, the cyst consists of connective tissue wall lined by ciliated epithelium.

Obviously such cases represent gross embryological malformation and resemble ours in their roentgenological and macroscopical, but not in their microscopical, features.

Echinococcus cysts of the pleura may also resemble the so-called simple cysts, but careful pathological examination reveals the true nature of this structure. The intradermal skin test is also of value in distinguishing this condition from the simple cyst. In the cases here reported an echinococcus cyst could be definitely excluded clinically.

Roentgenographically this entity presented an appearance somewhat different from encapsulated pleural effusion, which is often semicircular in outline but as a rule does not show such a complete circle as in this case. It is most commonly attached by a wide base either to the dome of the diaphragm or is situated along some part of the chest wall. Encapsulated interlobar effusion which often causes oval and at times even circular shadows was excluded by the fact that the structure was situated too far posteriorly from the anatomical position of the fissure.

From the clinical standpoint there was nothing indicative of a localized pyogenic or tuberculous process in the pleural cavity. There was no history of a previous pneumonia, which is one of the most common causes of pleural effusions, nor of an acute onset associated with pain during respiration. The remaining parts of the lungs showed no clinical or roentgenological evidence of a pathologic process. Despite the size of the lesion it did not cause any subjective symptoms.

CONCLUSIONS

1. A case of thin-walled cyst of the pleura, lined by a single flattened layer of endo- or mesothelial cells and containing a thin, clear fluid of low specific gravity is reported, the appearance of which simulated roentgenologically an echinococcus cyst.

2. The possible methods of formation of such cystic structures are briefly outlined.

3. The attention, particularly of the roentgenologist, is called to this condition which is believed to be the first reported case.

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THE THREE ZONES OF SIMPLE PLEURAL EFFUSIONS*

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THE upper border of simple pleural effusions has been described by many prominent clinicians during the past century. Of all descriptions, the one familiar to most is the S-shaped line of flatness known as the line of Ellis.[1] An excellent description of this line is to be found in the monograph of Garland.[2]

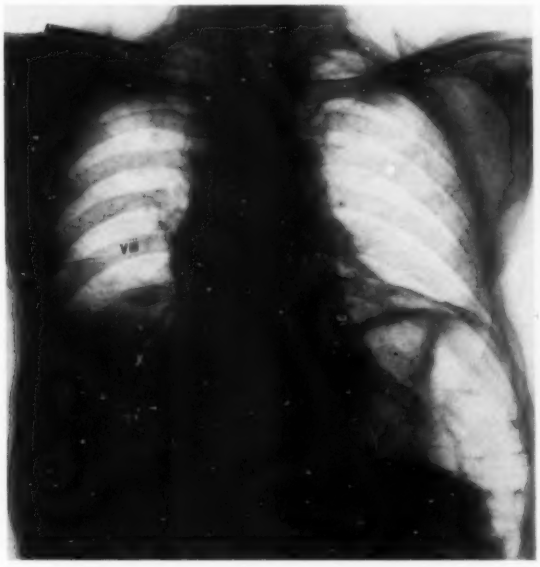

FIG. 1. Pleural effusion right side, showing the characteristic curved and hazy shadow. Note, for comparison with Figure 2, clarity of the eighth interspace.

Since the advent of roentgenography we have added to our knowledge of physical signs the curved shadow which together with the line of Ellis has come to be regarded as the upper border of simple pleural effusions.

In some experiments conducted in the study of liquid surfaces of pleural effusions,[3] I was able to show that in simple effusions the upper zone of liquid is too thin to cast a roentgenographic shadow, and that the upper border of the effusion is considerably higher than that indicated by either the curved roentgen shadow or the line of Ellis.

To make myself clear, I should like to explain that by a simple pleural effusion is meant here an effusion uncomplicated by pneumothorax, pulmonary consolidation or pleural adhesion to a degree sufficient to disturb the natural physical conditions. Figure 1 is an excellent example of such an effusion. It will be described in conjunction with Figure 2 to illustrate the three zones.

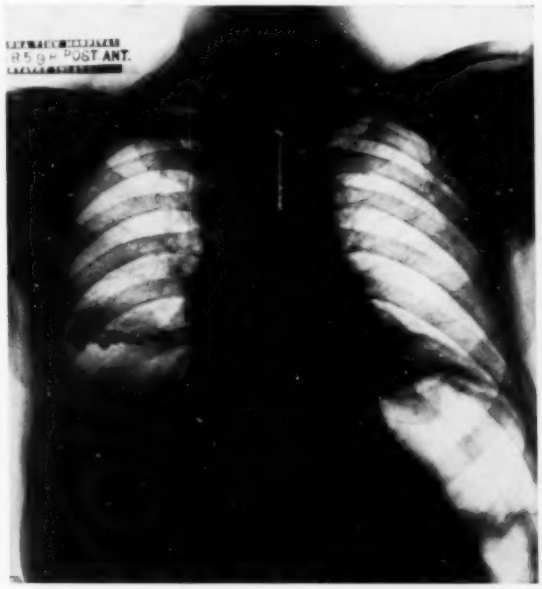

FIG. 2. Same case as Figure 1, after 10 c.c. iodized oil had been substituted for an equal volume of serum. The radiopaque oil is floating up to the interlobar fissure, showing that the liquid in its upper zone is too thin to cast a roentgenographic shadow, and that its upper border is considerably higher than the generally accepted dense curved shadow.

Looking at the roentgenogram (Fig. 1) we note, from below upward, first the characteristic dense shadow curving concavely upward from the hilus at the eleventh to

[1] Ellis, C. The line of dulness in pleuritic effusion. *Boston M. & S. J.*, 1874, *90*, 13.

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* From the Medical Service of Sea View Hospital.

the seventh rib in the axillary line. This shadow represents a large volume of liquid which has displaced the lung upward from the diaphragm. This is the first, or *radiopaque*, zone.

Above the dense shadow is a translucent shadow which extends to the upper border of the ninth rib. Lung markings are easily visible in this area because only a small volume of liquid is present interposed between the lung and chest wall. Judging

FIG. 3. Right oblique view of a pleural effusion. Substituted iodized oil (different technique from that in Fig. 2), seen as a homogeneous shadow over the ninth rib, has entered the interlobar fissure and is seen ascending in the parietal region as high as the sixth rib. The characteristic curved dense and hazy shadows are seen below.

from the gradually diminishing intensity of the shadow from below upward, we can infer that the intrapleural liquid correspondingly diminishes in this direction. This area, which we have named the *radiotranslucent* zone, can be seen to merge with the transparent zone above.

The third, or *radiotransparent* zone, noted above the ninth rib, gives no evidence of any effusion. That liquid is present here was proved by substituting 10 c.c. of an opaque oil (lipiodol in gomenol) for an equal volume of the effusion. As was expected, the oil rose to the surface of the effusion and so demonstrated its real upper border. This result is illustrated in Figure 2. The opaque oil is seen floating as large globules in the eighth interspace. The upper border of the effusion, according to this experiment, is the adhesion in the region of the interlobar fissure which crosses the eighth rib.

In the absence of adhesions, the effusion may extend considerably higher. This is illustrated in the Figure 3 which represents an oblique view. In this case the lipiodol was mixed with olive oil and gave rise to a more homogeneous shadow. In this roentgenogram are seen, first, the curved dense shadow below, above this the translucent shadow, and higher, crossing the ninth rib, the horizontal shadow produced by the oil which has entered the fissure between the upper and middle lobes in the transparent zone. In the axillary line immediately above the ninth rib is a triangular shadow which represents the opaque oil seen in the sagittal direction. Above and continuous with this triangular shadow is seen the thin film of liquid extending to above the sixth rib. This film is best visualized sagittally because of the greater denseness of the liquid when viewed in this plane.

The three zones of simple pleural effusions may then be described as follows, from below upward:

1. A *radiopaque* zone, made up of a large volume of liquid displacing the lung upward and casting a dense curved roentgenographic shadow.

2. A *radiotranslucent* zone, consisting of a moderate volume of liquid interposed between the lung and chest wall and casting a moderately dense roentgenographic shadow.

3. A *radiotransparent* zone, representing a film of liquid too thin to cast a roentgenographic shadow.

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LARGE ANEURYSM OF THE DESCENDING THORACIC AORTA WITH RETROPSOAS EXTENSION*

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WE PRESENT this case of unusual thoracic aneurysm for several reasons. Occurring in a woman, the size, direction, and extent of the vascular tumor were striking. In addition, and of more interest to roentgenologists, there was marked erosion of several vertebrae. These features would seem to justify a brief outline of the case history and findings before and after death.

CASE REPORT

Patient was admitted on December 3, 1934, with the following significant history: Twenty years ago, at the age of twenty-one, she contracted syphilis which was treated casually with mouth medication. One day after a transient paraplegia, which occurred eight years ago, generalized back pain developed which returned at intervals for fully six months. A blood Wassermann at this time was strongly positive and she was given active antisyphilitic treatment from that time up to the present. For four years she suffered pain in the left lower quadrant which was quite continuous and radiated to the back. Study eight months ago by roentgenograms disclosed what was considered to be an aneurysm of the lower thoracic aorta. A pulsating mass was noted at that time in the left lower quadrant, the identity of which could not be established. Since that time pain has been excruciating and morphine in large doses has been only temporarily palliative.

Present Admission. Chief complaint is of lower abdominal pain radiating to the left thigh. Patient's best weight was 160 lb. two years ago; is now 110 lb. Examination shows the following positive findings: Patient is a somewhat emaciated woman of forty-one. Pupils are slightly irregular. The left epitrochlear gland is palpable. Abdomen shows moderate distention with marked tenderness over the left lower quadrant. A cylindrical mass with slight diffuse pulsation can be felt in this quadrant with its lower border at Poupart's ligament. Tenderness and expansile pulsation are elicited in the left paravertebral area just above the twelfth rib. The blood Wassermann is four plus.

Roentgen Examination. February 16, 1934. Roentgen study of the urinary tract with pyelograms shows no definite evidence of disease.

February 19, 1934. Gastrointestinal examination after barium meal shows no evidence of abnormality. The descending colon overlies the mass palpated in the left lower quadrant, and is freely movable.

FIG. 1. October 2, 1930. In film of gallbladder area soft tissue mass is apparent in the dorsolumbar region; further study was not made at this time.

Roentgen examination of the dorsolumbar spine: A soft tissue, partly calcified globular shadow is present in the lower posterior mediastinum. Faint linear calcification suggesting a displaced aorta is visible about the upper and anterior boundaries of this mass. Erosion is present in the anterior portions of the bodies of the ninth, tenth, eleventh, and twelfth dorsal, and of the first lumbar vertebrae; the erosion extends for from 20 to 50 per cent of the depth of the individual bodies. The inter-

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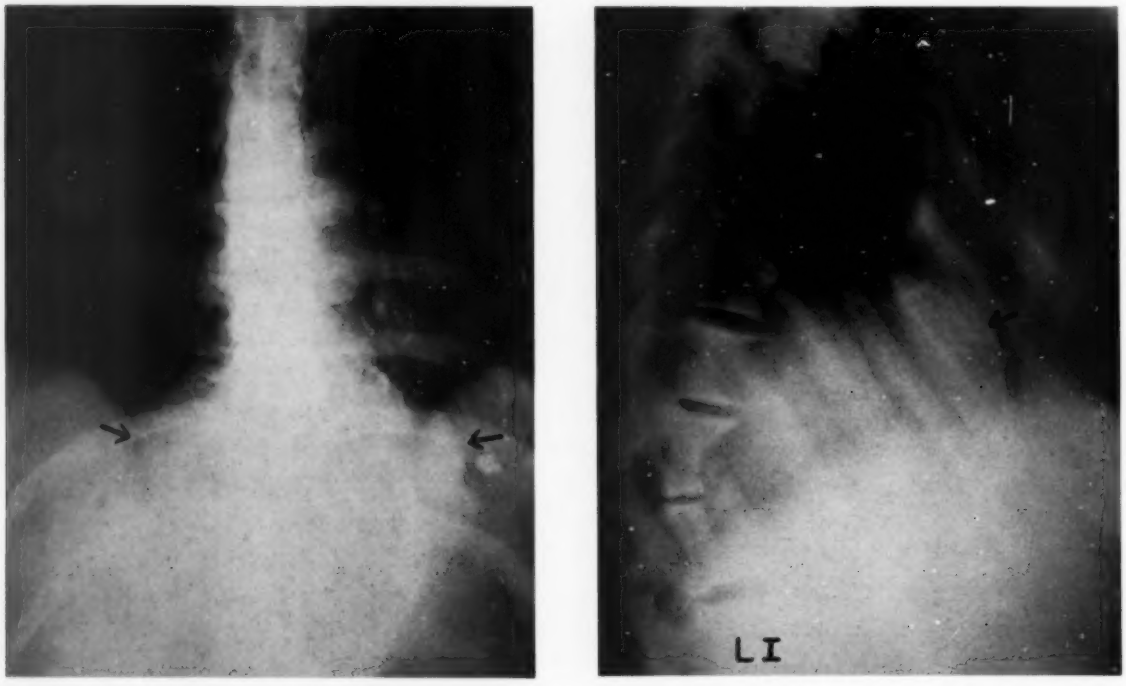
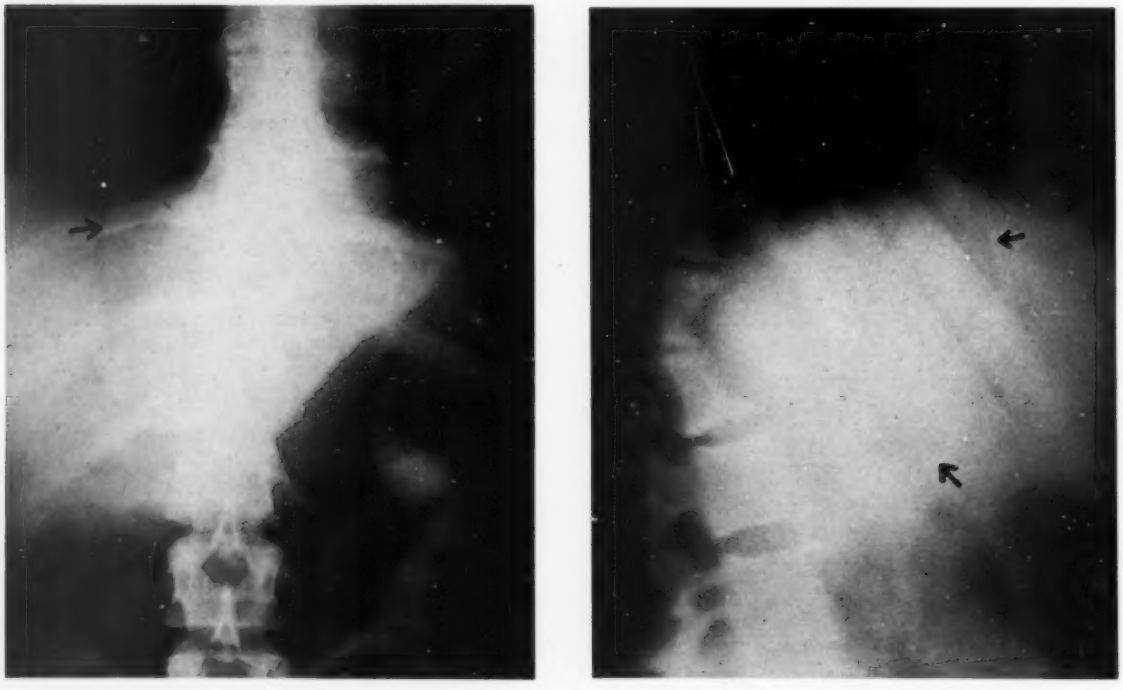


A B

FIG. 2, A and B. February 19, 1934. Saccular aneurysm arising from posterior wall of thoracic aorta just above diaphragm; marked erosion of several vertebral bodies; aorta is partially calcified and forms the superior and anterior borders of the mediastinal mass.



A B

FIG. 3, A and B. December 5, 1934. Aneurysmal mass has changed little in extent; slightly increased erosion of vertebrae and ribs.

vertebral spaces and adjacent portions of the vertebrae are not appreciably narrowed. Only slight kyphosis is present. No evidence of bone production is seen. There is also some loss of bone structure in the posterior portion of the left twelfth rib (Fig. 2).

Roentgenoscopy shows no abnormality of cardiac size, contour or pulsation. No definite pulsation is seen in the above noted mass, which extends well above both diaphragms; it does not move with respiration.

Diagnosis. Thoracic aneurysm with extensive vertebral erosion. Note: Upon review of cholecystographic study made in 1930, a small mass can be seen at the upper edge of the films which was not noted originally. This corresponds in location to the lesion under discussion (Fig. 1).

December 4, 1934. Roentgen examination of dorsolumbar spine: Although no apparent increase in size is noted in the soft tissue mass, increased scalloping is noted of the involved vertebral bodies; the posterior portions of the left eleventh and twelfth ribs show increased destruction (Fig. 3).

Morphine growing inadequate, she was given avertin and ether anesthesia on numerous occasions for relief of pain. Patient died on January 1, 1935, as the result of exhaustion.

Tentative diagnosis: (1) tertiary syphilis; (2) thoracic aneurysm; (3) left lower abdominal tumor (*a*) probably due to aneurysm, either dissecting from the thoracic aneurysm or a separate aneurysm, (*b*) possibly a retroperitoneal tumor (sarcoma).

Post-Mortem Examination (Dr. E. L. Armstrong): Following are the pertinent autopsy findings:

> . . . A large mass, present in the lower posterior mediastinum just beneath the aorta, . . . measures approximately 15 cm. in diameter at its widest portion, and extends from the body of the eighth vertebra down to the diaphragm, measuring about 12 cm. in length. It extends laterally on both sides of the spinal column, the greater portion of the sac being on the right side. . . . About 5 cm. above the diaphragm there is a large opening 4 cm. in diameter in the posterior wall of the aorta, which communicates with the large aneurysmal sac described above. This sac is filled with organizing blood clot and fibrin and some liquid blood.
>
> Extending downward from this sac a prolongation has eroded through the posterior attachment of the diaphragm on the left side behind the psoas muscle, stripping this muscle off of its attachment throughout its entire length. The left psoas covers the entire anterior surface of the aneurysmal sac; its tendinous part overlies the lower portion of the sac and this has probably prevented it from rupture at this point. This lower sac contains some liquid blood but is filled mostly with organized somewhat canalized blood clot. The wall of the sac measures approximately 3 to 4 mm. in thickness, is tough and fibrous in consistency, and shows no area where the wall is thin or weakened. The entire sac measures 15 cm. at its greatest width, and 33 cm. at its greatest length.

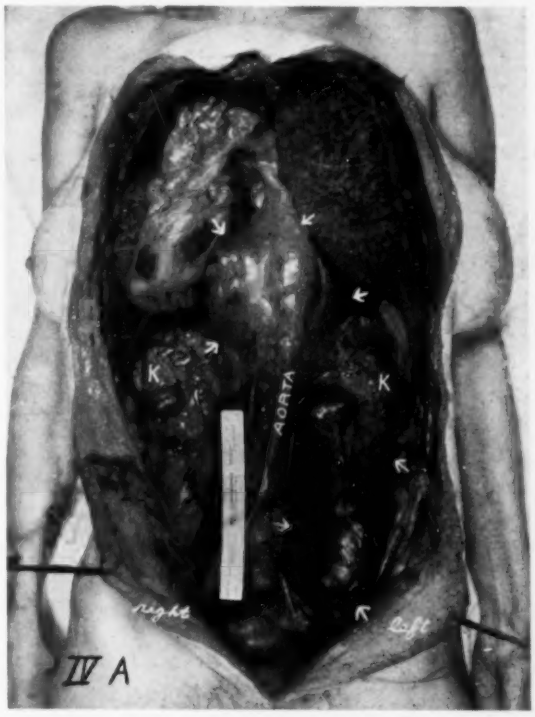


Fig. 4A. Photograph of aneurysm in situ showing relationship to aorta and urinary tract.

Examination shows marked erosion of the ninth, tenth, eleventh, and twelfth thoracic and first lumbar vertebrae; the bodies of the vertebrae have suffered more erosion than the intervertebral discs. Erosion is most marked in the eleventh and twelfth dorsal vertebrae, where the bodies are eroded a depth of 1½ inches; only about ½ inch of bone remains in front of the spinal canal. Erosion has also taken place in pockets on the lateral surfaces of the bodies and this eroded bony surface is found to form the posterior wall of the aneurysmal sac in these areas. On the left side the tip of the twelfth rib and the middle and proximal portions of the eleventh rib show complete erosion. These portions of the ribs are formed only by fibrous connective tissue. Only slight erosion of the ribs on the right side is noted (Fig. 4).

The heart shows no abnormality. The aorta shows a badly damaged intima throughout the entire thoracic portion and numerous areas are present where the intima has been eroded, leaving rough and

FIG. 4B. Photograph of aneurysm specimen with aorta opened longitudinally demonstrating the hiatus; lamellated blood clot is present.

ragged areas that vary in size up to 1 cm. in diameter. Throughout the thoracic aorta and particularly in the first portion and in the arch marked longitudinal striation and puckering are present, indicating syphilitic disease of this vessel.

On January 3, 1935, a roentgen examination of the post-mortem specimen of aneurysm and dorsolumbar spine was made. The soft tissue mass of the aneurysm is demonstrated showing slight diffuse wall calcification, most apparent as a ring 4 cm. in diameter in the upper anterior portion of the mass at origin of aneurysm. The contents of the aneurysm have a lamellated structure. The previously noted findings of erosion of the several vertebral bodies are verified. The intervertebral tissue is only slightly destroyed (Fig. 5).

Final Diagnosis: (1) cardiovascular syphilis; (2) thoracic aneurysm with retropsoas extension.

COMMENT

Aneurysm of the lower thoracic aorta occurred in 2 per cent of the 100 cases of aortic aneurysm analyzed by Brindley and Schwab; Lucke and Rea studied 263 cases of aortic aneurysm and found but 5 in the lower thoracic portion. Boyd gave the ratio of lower thoracic aneurysm to ascending arch aneurysm as 1 to 10, in a review of 4,000 reported cases. This same author states that aneurysm in general is 5.6 times more common in the male than in the

FIG. 4C. Photograph of involved portion of spine which shows the scalloping of the vertebrae caused by aneurysmal erosion; the interspaces and adjacent portions of the centra are relatively much less destroyed.

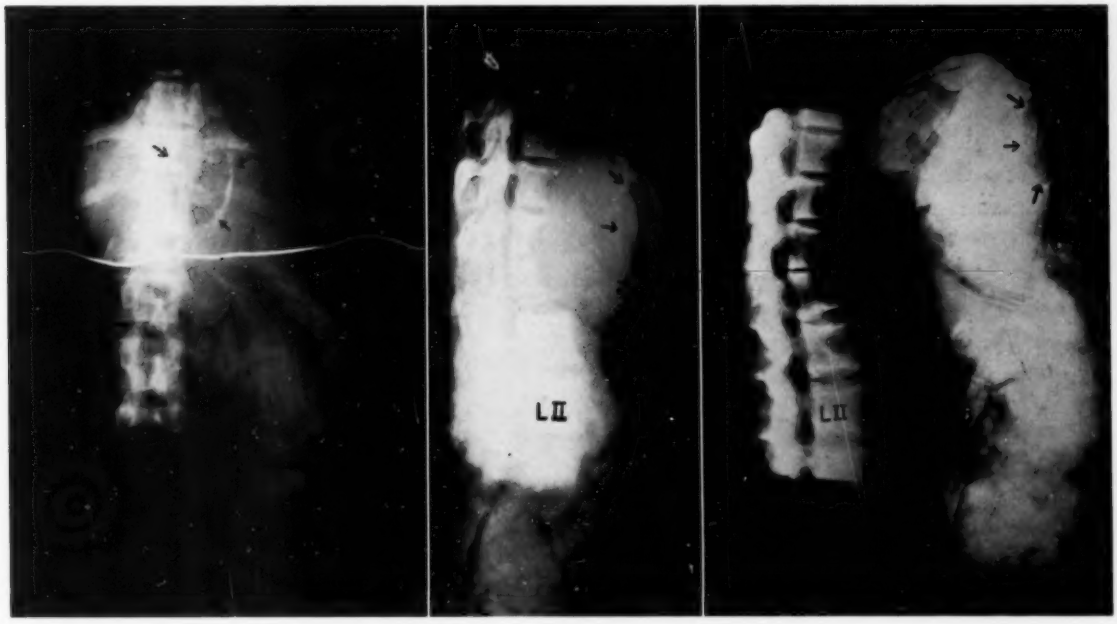
female. Lucke and Rea, in 25 thoracic aorta cases, had more than a 12 to 1 relationship, but 2 patients being women.

The direction of extent of thoracic aneurysm was noted in 21 of these last authors' series, 4 of the lower thoracic lesions extending posteriorly, and, with but one exception, to the left. Lucke and Rea state:

> The aneurysms lying just above the diaphragm may protrude into the muscular parts of the thoracic wall and attain huge size without perforation. The majority in our series extended posteriorly. In the thoracic aorta the aneurysms are commonly large and extend posteriorly and to the left eroding vertebrae and the ribs and rupture into the left pleura and lung. Rupture into the abdominal cavity also occurs.

In discussing the size of 27 of the series, these authors mention 2 as being huge (over 15 cm. in their maximum diameter).

Bone erosion is a common event in aneurysm. Vesalius, in 1555, recorded a case of thoracic aorta aneurysm which showed pulsation on the back; post-mortem study two years later confirmed the diagnosis and demonstrated marked erosion of the vertebrae just above the diaphragm. Brindley and Schwab, in their 100 autopsies, recorded erosion of vertebrae in 25, of ribs in 10. The Lucke-Rea series of 31 thoracic aorta lesions demonstrated vertebral involvement in more than 50 per cent, and rib involvement in 22 per cent. According to these investigators, "In bones only erosion seems to take place without demonstrable compression." The more extreme degree of vertebral erosion has occurred in abdominal aneurysms. Farmer reported 3 cases of considerable vertebral involvement from abdominal aneurysms, in each case involving the dorsolumbar area. One case in particular showed an upward displacement of the diaphragm centrally; the twelfth dorsal and the first three lumbar centra were narrowed "almost to the spinal cord."



A B C

Fig. 5, A, B and C. Roentgenograms of the post-mortem specimen demonstrate the relationship of aneurysm to spine. A and B—show the aortic hiatus as a ring of increased density; wire was placed at the diaphragmatic level. C—shows more clearly the effects of the aneurysm upon the vertebrae.

D'Istria, in summing up his observations of 5 aneurysms with vertebral erosion, submitted the following diagnostic points: (1) excavation of the spinal column; (2) preservation of discs; (3) more erosion of spongy centrum than of upper and lower laminae; (4) erosion not uniform in all parts; (5) double outline of excavation in roentgenograms in advanced cases due to (*a*) boundary between bone and soft parts; (*b*) boundary between partly eroded and normal bone. He stressed as the chief cause of the bone loss "mechanical causation of erosion"—the constant impact of differing resistances. Brailsford, in mentioning the scalloping of the anterior edge of the vertebra, states that if the erosion has been slow there may be apparent some sclerosis of the remaining bone. Marked vertebral erosion was demonstrated in cases recorded by Brailsford, and by Fooks. The former's case arose from the "posterior lateral border on the left side at the level of the coeliac axis. The sac had partially ruptured into the sheath of the left psoas muscle."

Boyd, in his analysis of 4,000 reported cases, found that in 50 cases of rupture of thoracic aorta aneurysm, 92 per cent ruptured into the thorax, 4 per cent into the spinal canal; 4 per cent into the stomach. In none of these cases reviewed is there mentioned by this or any other author retropsoas rupture or retropsoas extension of a thoracic or abdominal aneurysm, nor is there any mention of an extension of an aneurysm through the attachment of the diaphragm.

SUMMARY

1. A case is reported of aneurysm of the lower thoracic aorta in a woman, demonstrated roentgenographically for more than four years, and probably present for at least eight years.

2. Origin was from the posterior wall just above the diaphragm, with posterior direction.

3. The aneurysm extended behind the diaphragm at its left vertebral attachment, to become largely a retropsoas mass, with its lower border, Poupart's ligament on the left.

4. Bone erosion involved the lower four dorsal and the first lumbar vertebrae and the eleventh and twelfth ribs. The posterior wall of the aneurysmal sac was made up in places of the eroded bone surface.

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THE ROENTGENOLOGICAL DIAGNOSIS OF ABSCESS ON THE CONCAVE SURFACE OF THE LIVER*

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SOLITARY abscesses of the liver occur most frequently in the right lobe and extend to the under surface of the right leaf of the diaphragm. Here the convex surface of the liver is not entirely ensheathed in peritoneum and the abscess by its extension upward along the line of least resistance presses upon the under surface of the diaphragm and produces those characteristic changes described by Granger[5] and by Pancoast.[9] These changes consist of an obliteration of the right cardiophrenic angle in the posteroanterior view of the diaphragm, obliteration of the anterior costophrenic angle in the lateral view, elevation and fixation of the right leaf of the diaphragm, "pointing" of the abscess toward the right lung field and finally a pneumonitis at the base of the right lung.

When, however, the abscess forms in the left lobe or median portion of the liver, the line of least resistance is apparently downward toward the concave surface of the liver. The diaphragm is unaffected and the pressure of the epigastric tumor which forms is upon the stomach. It is in this location that the presence of an abscess may be unsuspected and the correct origin of a tumor undetermined on clinical examination.

That the occurrence of abscess in the left lobe of the liver is not so rare as might be expected is shown by the fact that various sources give the incidence as 10–20 per cent of all cases of liver abscess.[7,8,13] The surgical record of Charity Hospital shows that in the period 1925–1935 there were 85 proved cases of liver abscess, 8 of which occurred on the concave or under surface of the liver. In 3 of these 8 cases a gastrointestinal examination was made following the barium meal resulting in a correct diagnosis of the location and origin of the tumor. That the tumor was an abscess was our opinion in all cases, but in some instances the more general term of "tumor" was used and the specific diagnosis of abscess was made only in consultation with the clinician.

CLINICAL FEATURES

The clinical features of these 8 cases are worth considering inasmuch as they demonstrate the paucity and variability of the clinical findings. Males were affected more often than females and colored more often than white. The age limits were twenty to forty-six years. Two cases simulated perforated peptic ulcer and were diagnosed as such. Similar cases are reported in the French literature and the differentiation between the two conditions is shown to be extremely difficult when symptoms are acute.[1,4,10]

Of the 8 cases, one was secondary to and gave the history of an operation for perforated gastric ulcer six weeks previously. Another gave the history of diarrhea with bloody stool for three days one week prior to the onset of epigastric symptoms. The remaining 6 gave no history of dysentery or other conditions which might give a clue to the diagnosis.

The complaint was practically the same in all cases, namely, a dull upper abdominal pain which had lasted from two weeks to two months and was accompanied by an epigastric tumor and a loss of weight of from 15 to 20 pounds. In some instances the patients were unaware of the tumor in spite of its size and prominence. Some showed an intermittent elevation of body temperature varying in its upper limits

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FIG. 1. Case 1. Posteroanterior view of the stomach with the patient prone showing extrinsic pressure upon the lesser curvature and fundus with displacement of the stomach downward and to the left in a case of abscess of the left lobe of the liver.

from 99° to 102°F., associated with a leukocytosis of 12,000 to 15,000 white blood cells per cubic millimeter and a polymorphonuclear leukocytosis of around 90 per cent. Others had normal temperature and blood count. These latter were found to contain sterile creamy white pus (180 to 3,000 c.c.), while the cases with fever and leukocytosis were often either characteristically amebic (2 cases) or gave a positive bacterial culture (*B. pyocyaneus* 1 case).

Abscess was diagnosed clinically in 2 out of the 8 cases and localized in the liver in one. The other clinical diagnosis included epigastric hernia, perforated peptic ulcer (2 cases), carcinoma of the stomach vs. carcinoma of the head of the pancreas, abdominal aneurysm vs. pancreatic cyst, and carcinoma of the transverse colon.

CASE REPORTS

CASE 1. M.D., white male, aged forty-one. Eight months prior to admission this patient had a sudden severe colicky pain in the upper abdomen lasting several hours and repeated two weeks later, at which time the pain radiated to the right scapular region. Following the second attack he had a constant mild pain in the abdomen and at one time was jaundiced. He had lost 18 pounds in weight. Examination at time of admission revealed a large, smooth, tender epigastric mass with rigidity of the overlying muscle. No free hydrocholoric acid; white blood cells 7,750; temperature 98° to 101.5°F. The clinical diagnosis rested between cancer of the stomach, gumma of the liver, carcinoma of the head of the pancreas.

The gastrointestinal roentgenograms (Figs. 1 and 2) showed "an extrinsic pressure deformity along the lesser curvature and anterior wall of the stomach which is arising from the left lobe of the liver and is most probably an abscess of the left lobe." Operation showed a thick-walled gallbladder and a large bulging left lobe of the liver displacing the stomach posteriorly.

FIG. 2. Case 1. Lateral view of the stomach showing posterior displacement of the fundus by the abscess in the left lobe of the liver.

One pint of pus was removed from the abscess in the liver.

Case II. D.T., colored male, aged thirty-two, was referred to the hospital from the clinic suffering for six weeks with a constant dull aching pain in the upper abdomen, more particularly on the right side, and a gradually enlarging mass in the epigastrium for one month.

While attending the clinic a gastrointestinal examination was made and reported as a pressure deformity of the stomach and cap characteristic of a tumor of the left lobe of the liver (Figs. 3 and 4).

On admission to the ward because of the large pulsating epigastric mass, tender, and transmitting a systolic murmur, and because of the history of a chancre and the presence of fixed pupils, a diagnosis of abdominal aneurysm was made. A pneumoperitoneum, views of the spine, and a second gastrointestinal series were made and reported that the tumor arose from the liver and that there were not present the characteristic changes that would be produced by aneurysm.

The final preoperative surgical decision was a cystic retroperitoneal tumor believed to be a pancreatic cyst. Operation revealed a large abscess in the left lobe and median portion of the liver from which was aspirated one quart of thick creamy sterile pus. No amebae were found.

Fig. 3. Case II. Posteroanterior view of the stomach showing a large pressure deformity on the lesser curvature of the stomach and cap. An abscess was found on the concave surface of the liver containing one quart of pus.

Fig. 4. Case II. Lateral view showing slight posterior displacement of the stomach; less than Case I since the abscess lies more medially.

Case III. L.A., colored female, aged forty, had suffered with cramping epigastric pain and an epigastric mass for four weeks and had been under a doctor's care. During this time she had a great decrease in weight. On admission she showed a temperature of 99.5°F. and a firm movable tumor mass 4 cm. in diameter lying transversely in the epigastrium. A clinical diagnosis of carcinoma of the transverse colon was made but the roentgen report was a tumor of the median portion of the liver (caudate lobe) (Figs. 5 and 6).

An exploratory operation revealed an amebic abscess in the median portion of the liver adherent to the anterior abdominal wall; 180 c.c.

FIG. 5. Case III. Extrinsic pressure on the lesser curvature of the stomach from an abscess on the concave surface of the liver.

of pus was aspirated and five months later the patient returned to the hospital and 500 c.c. was evacuated. Amebae were not found in repeated examination of the stool or pus and proctoscopic examination showed no ulceration of the colon.

ROENTGENOLOGICAL FINDINGS

As is seen from the accompanying illustrations and case reports an abscess of the concave surface of the liver, which we believe to be the most common tumor at this site, produces a characteristic pressure deformity on the barium-filled stomach. To best demonstrate this deformity it is necessary to make roentgenograms in the prone position so the entire stomach will be filled with barium and in contact with the liver and in the lateral position so that further and more accurate localization of the site of the tumor can be made and other possible sites excluded.

In these positions the abscess presses upon the lesser curvature of the stomach which assumes a more or less crescentic shape. The pressure is uniformly distributed along the lesser curvature and as the abscess increases in size the cardia and the duodenal cap are displaced (Fig. 3).

As the abscess enlarges, the cardia is displaced to the left, the remainder of the stomach downward and to the left and the duodenal cap downward and slightly toward the right. In the lateral view, if the tumor lies in the left lobe, which overlaps the anterior wall of the stomach, there is a definite posterior displacement of the cardia and upper end of the fundus (Fig. 2). The more medially the abscess is located the less posterior displacement there is of the stomach (Fig. 4) until the abscess is confined to the median portion (caudate lobe), in which case it lies posteriorly and displaces the stomach forward if at all (Fig. 6).

DIFFERENTIAL DIAGNOSIS

Although with such a roentgenographic appearance our first thought is of a liver abscess and, until proved otherwise, an amebic abscess, we realize that other conditions may produce a similar picture.

FIG. 6. Case III. Lateral view showing slight anterior displacement of the stomach by an abscess in the median portion and on the concave surface of the liver.

Other tumors on the concave surface of the liver must be considered, namely, echinococcus cyst, metastatic carcinoma, hemangioma and particularly gumma.

Echinococcus cysts, which are rare, are very often calcified. Metastatic carcinoma does not commonly produce a large mass on the under surface of the liver and the mass quite probably would not have the smooth border found in an abscess. Cavernous angioma is also rare but must be considered.

Gumma is no doubt the most frequent of the tumors arising from the liver which can produce the same pressure deformity of the stomach as an abscess. In one of our cases of gumma producing such a deformity, antiluetic treatment resulted in a marked diminution of the size of the tumor within three weeks, verifying the clinical diagnosis.

Cyst of the lesser omentum or a malignant growth filling the lesser peritoneal space from a primary source in the stomach is a possibility. Pancreatic cysts may give a similar deformity, but it has been our experience that they displace the stomach upward almost invariably.

COMMENT

From a review of the cases here presented it is seen that the clinical diagnosis of hepatic abscess is often overlooked when the pathology is present in the left or median portion of the liver, and that although a tumor can be palpated its origin from the concave surface of the liver may be unsuspected clinically.

Conversely, the origin of an epigastric tumor from the concave surface of the liver is readily and more or less accurately determined roentgenographically by means of a gastrointestinal examination, and, with the possible exception of gumma, an abscess is by far the most common large tumor arising from this region. One thus realizes the importance of the roentgen ray in the diagnosis of this condition.

SUMMARY

The difficulty of the clinical diagnosis of liver abscess is shown when the abscess occurs in the left or median portion of the liver.

The incidence of liver abscess in this location is seen to be from 10–20 per cent of all cases of liver abscess.

The only constant clinical finding in eight cases considered is the presence of an upper abdominal tumor.

Three cases are reported showing the importance of the gastrointestinal examination in the diagnosis and location of the tumor (abscess).

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THE RECTIFICATION OF ERRORS IN THE DIAGNOSIS OF MOVEMENT OF URETERAL CALCULI

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THE principle underlying the method of diagnosis which I am about to describe is of such simplicity as to have been noticed in all probability by the majority of roentgenologists. Yet it appears that no one has made this small addition to the roentgen literature and many have not applied it in the determination of the descent of urinary calculi.

Not infrequently the roentgenologist and urologist are misled into thinking that a stone has descended 1 or 2 centimeters as compared with a definite portion of the spine without recognizing the fact that the central ray has penetrated the abdomen at a point considerably at variance with that on the previous examination. One immediately appreciates the fallacy of making a comparison in such a case by observing the relationship between the transverse processes of the vertebrae and the calculus when it is brought to his attention that these processes and the ureter are in different planes. A study of gross anatomy in cross section[1] from the level of the upper pole of the left kidney to the bladder indicates that in the average patient the kidney pelvis, and upper and mid ureter, are 3.75 to 4.5 cm. anterior to the transverse processes. The lower ureter is 5.5 cm. anterior to the sacral foramina or from 8.0 to 8.5 cm. anterior to the sacral spinous processes. Cognizance of these facts provides for the application of the law that the movement of an opaque body as represented on the screen or film in relation to the movement of the tube is directly proportional to its distance from the anode. This law is the basis for the majority of methods of foreign body local-

[1] Eycleshymer and Schoemaker. A Cross-Section Anatomy. D Appleton and Co., New York and London, 1911, pp. 142–187.

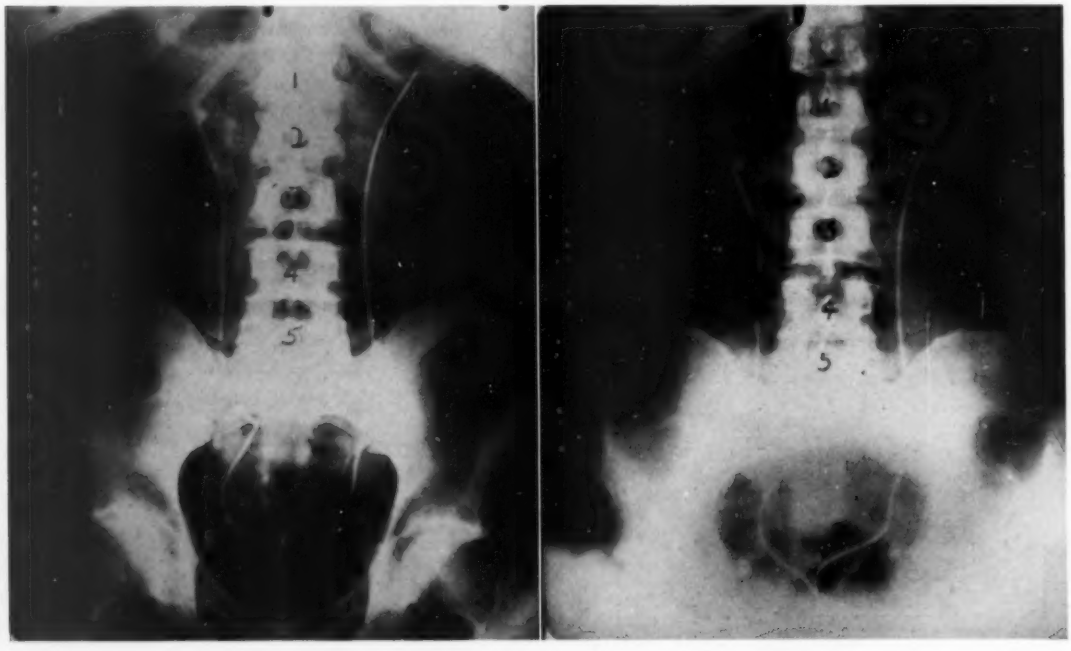

FIG. 1 FIG. 2

FIGS. 1 and 2. In Figure 2 the tube has been shifted cranially and the renal calculus has moved closer to the transverse process of the second lumbar vertebra.

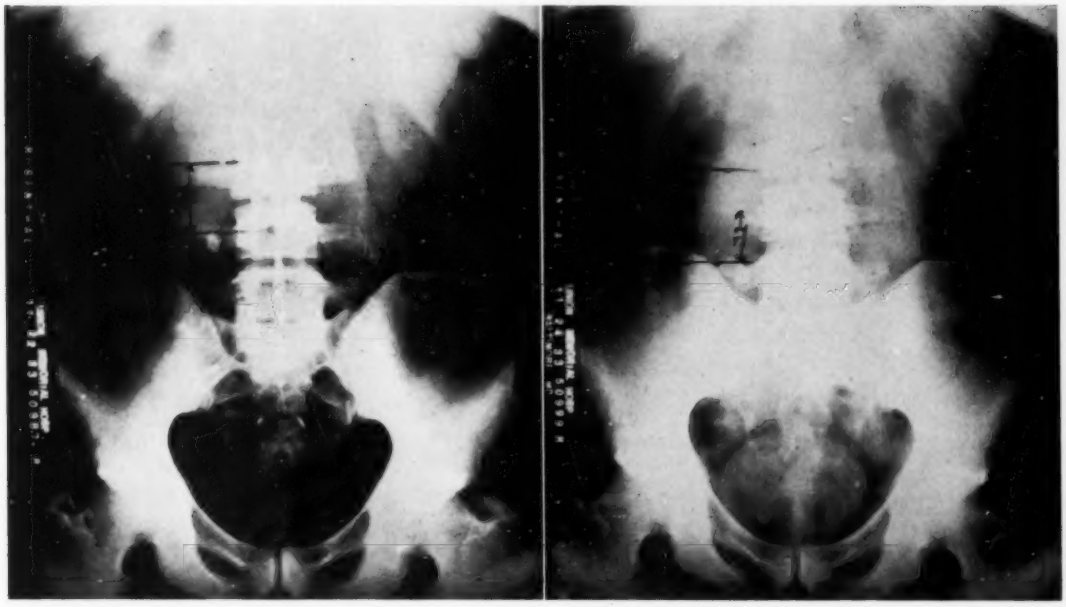

Fig. 3 Fig. 4

Figs. 3 and 4. In Figure 4 the patient had not exhaled completely. The lower pole of the right kidney is 1.5 cm. lower than in the previous examination. Because of constancy of the tube-patient-film relationship an accurate comparison with the transverse processes is possible.

ization and was first expressed by Buguet and Gascar,[2] in 1896, as follows:

$$\text{Depth (of foreign body)} = \frac{b \times h}{a + b}$$

in which a represents the shift of the tube, b the degree of shift of the shadow of the foreign body, and h the anode-film distance. Therefore, when the anode of the tube is shifted cranially or caudally with regard to the patient, there will be considerably more shifting of the shadow of the calculus than that of the vertebral processes.

Reference to Figures 1 and 2 will demonstrate this fact clearly. In Figure 2 the anode has been shifted cranially and the shadow of the renal calculus has moved closer to that of the transverse process of the second lumbar vertebra.

This difficulty can be overcome very easily by maintaining a constant anode-patient-film relationship. The anode-film distance should be constant, and anatomical landmarks, such as the superior aspect of the greater trochanters or the upper border of the symphysis pubis, may be made to correspond with certain markings upon the roentgenographic table. Centering the tube to the film in the Potter-Bucky carriage is a universally established practice.

When it is desirable to make comparisons in which this constancy was not maintained, one can determine the degree of descent of a stone by using the lower margin of the kidney as a landmark, provided the films were taken in full expiration. This is more accurate than comparison of bony landmarks under these conditions because of the fact that the lower pole of the kidney is more nearly in the same plane with the abdominal ureter than the vertebral transverse processes. If the exposure is not made on complete expiration such a study is impossible because of mobility of the kidneys. For example, the position of the patient in Figure 4 duplicates that in Figure 3. As compared with the transverse processes the calculus has descended in the

[2] Buguet and Gascar. Determination a l'aide des rayons X de la profondeur ou la siege d'un corps etranger dans les tissus. *Compt. rend. Acad. d. sc.*, 1896, p. 457.

right ureter 3.2 cm., whereas comparison with the lower pole of the right kidney would indicate that it has descended only 1.7 cm. It is observed in Figure 4, however, that the patient had not exhaled completely before the exposure was made.

The value of technical constancy is recognized in the fact that it permits diagnostic accuracy. Misinterpretation as to movement of a calculus may lead to unnecessary delay in operative interference and additional danger to the patient. Therefore, it has seemed worth while to describe a method of avoiding these pitfalls.

HODGKIN'S DISEASE OF BONE MARROW AND LIVER WITHOUT APPARENT INVOLVEMENT OF LYMPH NODES*

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THE following case of Hodgkin's disease of the bone marrow without apparent involvement of lymph nodes is reported for several reasons, chiefly, however, because of its rarity. The only other case resembling it was reported in 1931 by Krumbhaar,[3] although Rolleston[6] had reference to that case earlier, in his Schorstein Lecture on Hodgkin's disease in 1925; and Muller and Boles,[4] reporting a group of cases of abdominal Hodgkin's disease mentioned it in 1927. Krumbhaar's case differed from the present one in that the spleen was also involved, whereas there was no evidence of such involvement in the one here reported. The liver, however, showed extensive involvement, evident macroscopically, on the surface of the organ as well as on cut section, by widespread whitish lesions, pin-point to pin-head in size. Microscopically the sinuses were filled with large mononuclears, as well as multinuclear giant cells of the Reed-Sternberg type. In some areas the liver architecture was completely replaced by the typical structure of Hodgkin's disease.

Not the least striking of the many unusual features of this case were the roentgenograms of the bones, which showed,

FIG. 2. Discrete, circular areas of various sizes diffusely scattered throughout the skull. The lesions resemble multiple myeloma.

where the lesions were manifest, changes generally associated with other conditions than Hodgkin's disease. The lesion in the left ischium thus resembles a metastatic carcinoma, while the skull, also resembling metastatic carcinoma in some respects, suggests even more strongly multiple myeloma (Figs. 1 and 2). The ribs and spine, grossly negative on the roentgenograms, showed extensive lesions at autopsy, a discrepancy that cannot be accounted for solely by the fact that there was a difference of some two weeks between the time these plates were taken and the postmortem examination, the lesion being too far advanced to have developed in that short interval. Various investigators have

FIG. 1. Destructive lesion in left ischium with pathological fracture traversing it. The lesion resembles a metastatic malignancy.

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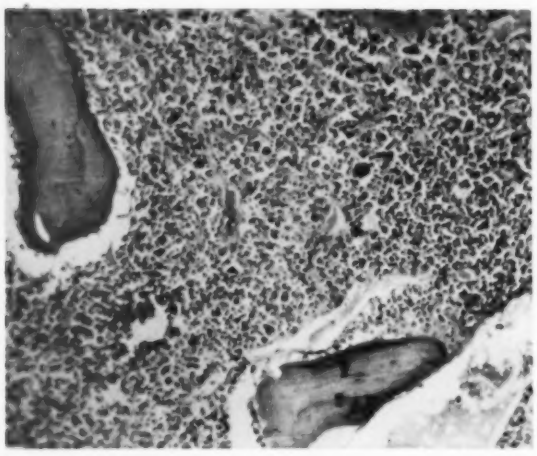

FIG. 3. Section taken from body of third lumbar vertebra showing involvement of bone marrow by Hodgkin's disease.

shown that even fairly well-advanced lesions may be present in bone without their being demonstrable roentgenographically. When the lesions are as destructive in character as they were in this case the probability of their detection on the film is, of course, increased; but lesions which develop more slowly, thereby affording an opportunity for a reparative reaction to take place, are less prone to be detected by that method. Reisner and Brada[5] dissected the spine of a case of Hodgkin's disease in which they suspected involvement of this portion of the skeleton, and while roentgenograms of the dissected specimen revealed no abnormalities, cut section showed extensive involvement by Hodgkin's disease. This, as well as our own experience, shows how easily lesions of bones may be missed, and how difficult an estimate of the percentage of bone involvement in Hodgkin's disease would be. Histological studies of bone from autopsy material of cases of Hodgkin's disease yield, as one would suspect, a much higher percentage of positive cases than roentgenographic studies do. Ziegler[9] believed such evidence could be demonstrated in from 30 to 40 per cent of all cases; Symmers[7,8] in 50 per cent; while Geschickter,[2] quoting Ewing,[1] states that careful enough studies will reveal positive histological evidence of the disease in the bones in practically all cases coming to autopsy.

Considering the frequency with which the bone marrow is involved, one may ask why the disease is not more frequently found in this tissue primarily without accompanying lymph node involvement. It is entirely possible that in some cases it does exist primarily in the bone marrow, but due to the difficulty in demonstrating such lesions, and the great tendency to involve the lymph nodes, it is not discovered until the latter structures have also become involved and the disease has been identified from the source. Since an exhaustive search in our case failed to reveal even a single involved node (the lymphoid areas of the digestive tract were also subjected to a very thorough search without a single focus of Hodgkin's disease being found), it may reasonably be assumed that, in this case at least, as in the case referred to which Krumbhaar reported, the disease was primary in the bone marrow.

CASE REPORT

A white male, aged forty-one, employed as a kitchen helper, was admitted to the wards of the Edward Hines Memorial Hospital July 30, 1934, stating in his history that his present illness was of six weeks' duration; that it was characterized by acute episodes of severe backache generally coming on after exertion; and that a residual soreness persisted even after the acute attack subsided. During this period he had had a constant feeling of weakness in his

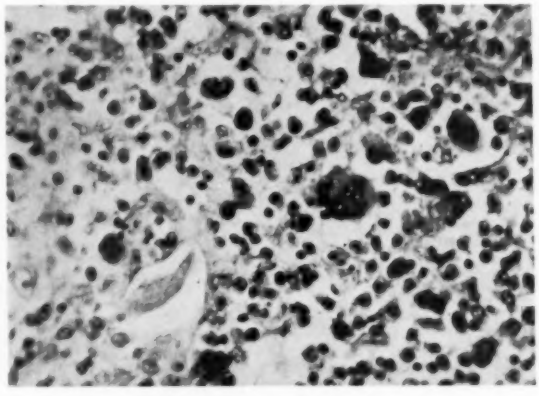

FIG. 4. Same section as in Figure 3 under higher power showing cellular detail.

back making him apprehensive when bending over sharply or when using his back muscles. On one occasion, ten days preceding his admission, while trying to lift some meat from the floor, his back suddenly gave way so that he fell to the floor and could neither get up again nor turn over on his side. He was placed in a wheel-chair and taken to his quarters where he remained for five days. At the end of this period he was considerably improved so that he felt well enough to resume his former duties in the kitchen. He worked four days during which time his backache became increasingly severe and he was again sent back to his quarters. The next day he was admitted to the hospital for study.

Past History. The patient had had the usual childhood diseases. In May, 1930, he had a previous hospital admission for acute appendicitis. The postoperative course was complicated by a bilateral lobar pneumonia which resolved in seven days. Aside from this his past history was essentially negative.

Family History. Father died at the age of fifty-six, cause unknown. (Patient stated that his father had been a heavy drinker.) Mother died when patient was an infant, cause unknown. No brothers or sisters. There was no known history of tuberculosis or cancer in the family.

Social History. Patient had been a cook; in the last five years he had been employed by the hospital as a kitchen helper. He had gonorrhea in 1916, but denied chancre. Does not use alcohol or drugs.

Physical examination revealed a well-developed and nourished white male, lying on one side. The eyes, ears and nose were negative. The teeth were replaced by artificial dentures. The tongue was coated. The tonsils and pharynx were negative. There were no abnormal pulsations in the neck, nor was there any cervical adenopathy. The trachea was in the midline. The heart and lungs were negative. The abdomen was entirely negative save for an appendectomy scar in the right lower quadrant. Neither the spleen nor the liver was palpable. There was no inguinal, supraclavicular, or infraclavicular adenopathy. No herniae were noted. The genitalia and anus were negative. Rectal examination was negative. The patient had good control of the bladder and rectum. The extremities were negative. Blood pressure: 116 systolic, 68 diastolic; pulse 82; temperature 98°F.

Laboratory Findings. July 31, 1934. The Wassermann test was negative and the Kahn reaction was +1. Urine: negative save for a heavy trace of albumin. Blood: red blood count, 4,600,000; hemoglobin 85 per cent; white blood count, 10,000; no differential count made. August 19, 1934. White blood count, 8,200; polymorphonuclears, 70 per cent; small mononuclears, 21 per cent; large mononuclears, 9 per cent. August 20, 1934. Urine for Bence-Jones albumin, negative. August 21, 1934. Blood calcium 14.9 mg.; phosphorus, 2.7 mg. September 4, 1934. White blood count, 3,750; polymorphonuclears, 60 per cent; small mononuclears, 31 per cent; large mononuclears, 9 per cent.

Clinical Course. Patient suffered from severe backache during the entire period of hospitalization. August 9, 1934: Examination at this date by the orthopedic surgeon revealed a well-nourished white male unable to stand or walk, lying on one side. The lumbar lordosis was obliterated, although there was no scoliosis. The erector spinae muscles were spastic; marked tenderness over the entire lumbar spine and sacroiliac joints was elicited. The roentgenographic examination showed the changes in the skull and left ischium noted in Figures 1 and 2. The patient on this date had another attack of excruciating pain in the back; became cold, clammy and cyanotic; perspired profusely and was obviously going into shock. He had to be given morphine for the pain. The clinical diagnosis at this time was metastatic malignancy, an opinion strongly borne out by the roentgenograms. The patient was too ill to warrant the necessary diagnostic procedures to discover the primary malignancy; and the genitourinary examinations, gastrointestinal studies, etc., which had been contemplated had to be temporarily abandoned. August 23 to September 1, 1934: A course of deep roentgen therapy was given over the lumbar area, 1,850 r being the total dose. The patient's chief symptom, backache, was somewhat improved following this treatment. September 2, 1934: Patient was unusually uncomfortable. He was noticeably dyspneic and cyanotic and complained of severe pain in the right lower chest aggravated on deep breathing: he was evidently developing pneumonia. The physical examination revealed dullness, increased voice and whispered sounds, increased fremitus, and crepitant râles over the right lower chest more marked posteriorly. A bedside roentgenogram

of the chest showed an early pneumonia of the right lower lobe. September 3 to 6: The clinical picture was now that of an advancing pneumonia. The physical signs heretofore confined to the region of the right lower lobe were also present in the region of the middle lobe. The breathing was more rapid and shallower than it had been; the cyanosis increased; on the last day the patient was semiconscious and evidently moribund. September 7, 1934: Patient expired at 1:15 P.M.

Autopsy Abstract. (Autopsy was performed by Dr. McNamara one hour after death.) The body is that of a well-developed and well-nourished white male properly identified as the one previously named. Body length 167 cm. Body weight about 146 lb. Hair is dark, pupils equal, teeth are artificial. There is an old scar over McBurney's point. No other external marks are noted. No superficial glands are enlarged.

Peritoneal Sac: There is a normal pad of subcutaneous fat. Muscles are of good color. Peritoneum is smooth. No excess of fluid is noted. Liver is not enlarged. Spleen is not enlarged. There are no enlarged intra-abdominal lymph nodes.

Chest: There are ancient adhesions to the chest plate. Old adhesions are noted over both lungs. There is no fluid. The right lower and middle lobes are solid. Pericardial sac occupies normal position. Pericardium is smooth. No excess of fluid is noted.

Heart: Heart weighs 320 grams. Muscle is of fairly good color and consistency. There is no evidence of any valvular lesion. Mild endocardial thickening is noted. A few atheromatous plaques are noted in the coronaries and the upper portions of the aorta. The remainder of the aorta and the peripheral vessels are clear.

Lungs: The right lung weighs 500 grams. Lower and middle lobes are solid. Surface is shaggy with old adhesions. On section there is a confluent bronchopneumonia in the lower and middle lobes. The upper lobe is negative. The left lung weighs 300 grams. It is inflated and the surface is shaggy. On section the markings are normal. Mediastinal glands are negative.

Liver: The liver weighs 1,700 grams. The surface is smooth. On section there are noted tiny pin-head sized, white tumor nodules throughout the parenchyma. These nodules are also visible on the surface of the organ. Histological section shows the liver sinuses filled with large mononuclear and multinucleated cells. The liver architecture is replaced by a typical Hodgkin's structure in some areas.

Gallbladder: Negative.

Spleen: The spleen weighs 180 grams. Grossly and histologically negative.

Pancreas: The pancreas weighs 120 grams. Grossly and histologically negative.

Genitourinary Tract: The right kidney weighs 150 grams. The left kidney weighs 160 grams. Both kidneys are grossly and histologically negative. Both adrenals are firm and the markings are well preserved and histologically negative. The bladder, prostate, and vesicles reveal no gross pathological lesion, although the prostate is somewhat harder than normal. It is histologically negative.

Gastrointestinal Tract: This reveals no gross pathological lesion. The lymphoid areas are grossly and histologically negative.

Brain: There are no adhesions between the dura and the calvarium. On removal, the calvarium when held to the light reveals tiny punched-out areas in the bone. The largest is about the size of a split pea. On section they are filled with white gelatinous-like material; others show a pinkish meaty-like material. The brain weighs 1,500 grams. It is grossly negative.

Bony Skeleton: In the lumbar vertebrae, ribs, calvarium, and pelvis are noted punched-out areas varying in size. The areas in the ribs are about the size of a pin-head to a split pea. The areas in the lumbar vertebrae are as large as a quarter and on section filled with gelatinous-like material in places; in other places with pinkish meaty-like substance resembling multiple myeloma.

SUMMARY

1. A case of Hodgkin's disease of bone without apparent involvement of lymph nodes is presented, only one other case of this type having been recorded in the literature.

2. The case was characterized by an acute clinical course: only three months in duration from the onset of symptoms to the time of death.

3. The roentgenograms of the involved bones suggested a metastatic malignancy; in the skull the appearance resembled multiple myeloma.

4. The frequency of bone marrow involvement in Hodgkin's disease is considered. Such involvement is much more common than is ordinarily suspected, and, as some investigators believe, may be universal in advanced cases.

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ON THE TECHNIQUE OF ENCEPHALOGRAPHY

WITH SPECIAL REFERENCE TO THE USE OF APPARATUS*

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(1) INTRODUCTION

IN 1918 Dandy[8,9] introduced the replacement of cerebrospinal fluid by gas as a diagnostic procedure. There are three general methods of replacement, namely, ventriculography, encephalography and myelography.[6] Of these ventriculography and encephalography are most frequently used. In myelography gas is introduced into the subarachnoid in order to outline the vertebral subarachnoid spaces. In ventriculography gas is introduced into the ventricular system by means of direct ventricular puncture through trephine holes. In encephalography gas is introduced into the ventriculosubarachnoid space through subarachnoid puncture at the cisterna magna or lumbar sac. Each has its specific indications and contraindications. Both are safe and useful diagnostic procedures when used correctly.[2,4,15,16,18,19,24,25,30,31] In 1921 Bingel[3] and Wideroë[36] emphasized the value of encephalography. Since then it has been used with increasing frequency. Consequently there have been numerous modifications of encephalographic technique. Various methods of subarachnoid puncture have been advocated and several types of apparatus have been described. The value of these methods and pieces of apparatus would have been enhanced by a clearer conception of the dynamics involved in encephalography. *The importance of any piece of apparatus lies not so much in its design as in its proper use.*

The purpose of this article is to discuss the prevailing methods of encephalography, to suggest a standard technique, and to present a new apparatus* designed to demonstrate and control the dynamics of encephalography.

* The finished product was manufactured by the Macalaster Bicknell Co. of Cambridge, Mass.

(2) HYDRODYNAMICS OF ENCEPHALOGRAPHY

The hydrodynamic changes occurring during encephalography are of fundamental importance. They must be fully appreciated before any technique or apparatus can be used intelligently. In an adult human sitting erect, the cerebrospinal fluid pressure at the fourth lumbar vertebra is about 450 mm. of water,† at the cistern about atmospheric, and at the ventricles about 150 mm. below atmospheric pressure. As spinal fluid is drained from the lumbar sac, all three pressures decrease until the lumbar equals atmospheric pressure. If gas is introduced at atmospheric pressure, as the spinal fluid is drained, all of the fluid may be removed. The subarachnoid pressure at the lumbar sac will then equal atmospheric pressure. This occurs whether the gas is introduced by syringe in large or small volumes, or whether it is introduced from a closed container in which the gas was originally at atmospheric pressure. When the spinal fluid has in such fashion been completely replaced by gas, the column of gas exerts a negligible gravitational force upon the lumbar pressures. Hence, the pressures all along the craniovertebral axis are equal whether the patient is erect or recumbent. After complete replacement of cerebrospinal fluid by gas, it is therefore advisable to maintain in the erect position a final lumbar subarachnoid pressure about equal to the original lumbar spinal fluid pressure in the recumbent position (about 150 mm.). If this is done, the intracranial pressure will again become normal (150

† Hereafter pressure (force per unit area) will be indicated in millimeters of water, the usual clinical units. That is, that pressure which will support a column of water so many millimeters against atmospheric pressure (760 mm. Hg = 14.6 lb./sq. in.). For example: 136 mm. of water = 10 mm. Hg = 0.19 lb./sq. in. pressure.

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mm.) when the patient is returned to bed. In order to maintain a final cerebrospinal fluid pressure at the lumbar sac of about 150 mm. while the patient is sitting erect, it is usually necessary to introduce a volume of gas larger than the volume of fluid removed. The increase in intracranial pressure, which might occur as the gas attempts to expand when it is raised from room to body temperature, does not seem to be as important as might be expected. As the craniovertebral spinal fluid system is not rigid, but partially elastic, volumetric computations cannot give an accurate conception of the pressure changes produced by the replacement of spinal fluid by a gas. Pressures produced must be measured directly. Due to the physiological mechanisms involved, each patient reacts in a somewhat different fashion; therefore, pressures must be frequently measured. These observations have recently been made in man and confirmed in vitro.[31,32]

(3) METHODS OF ENCEPHALOGRAPHY

This study is concerned solely with the injection of gas by the lumbar route, that is, lumbar encephalography. Cisternal insufflation is considered unnecessarily dangerous due to the proximity of the needle to the vital medullary structures. This prevents adequate manipulation of the patient's head, which in turn results in poorly and unequally filled ventriculosubarachnoid spaces. The published results are as yet not impressive.[5a,18,27,33] The usual method of encephalography entails replacement of cerebrospinal fluid by a gas through one or two lumbar puncture needles inserted into the subarachnoid space at about the fourth lumbar vertebra, while the patient is maintained in the sitting position.

In order to eliminate the second puncture, many physicians prefer to replace the cerebrospinal fluid through a single needle.[1,2,4,10,19,22] The deceptive simplicity of this method covers a multitude of sins. Cerebrospinal fluid cannot be replaced by gas through a single aperture without causing alternate depression and elevation of the subarachnoid and intraventricular pressures. These shifts of pressure vary directly with the volumes replacing each other. Such alternations contribute to the discomfort and untoward reactions of the patient. They have been considered conducive to a herniation of the medulla and cerebellum into the foramen. Another result may be cerebral and medullary edema with its untoward symptoms.[23,32] Certainly such alternate pressures must tend to produce alternate constriction and dilatation of the cerebrovascular bed which is in effect a massage of the intracranial contents.[32] In order to minimize the pressure shifts, small volumes must be exchanged at each step (5 c.c. or less). This unduly prolongs the procedure which in turn aggravates the patient's symptoms. In addition, the single puncture methods require the constant attention of the operator, whereas he had best be centering his attention upon manipulation of the patient's head. The only circumstance in which a single needle method is more advantageous than the double needle method is when two punctures are technically impractical as in infants or very small children.

Davidoff and Dyke[10] have described a method of encephalography which is based upon the single puncture method. The roentgenograms resulting from this method are far superior to any as yet published.[11,12,13] The results of this single needle method are worthy of extended trial in other clinics.

Various methods have been devised to facilitate the single puncture approach. Most of these are variations of the connections between syringe and manometer.[5,22,34] Sommer[29] has described a compact apparatus applicable to ventriculography or encephalography. It is in effect a chamber with attached manometer interposed between syringe and needle. The manometer is a mercury U-type, and hence subject to criticism. The chamber is not large enough (130 c.c.) to accommodate the volumes of fluid frequently removed in en-

cephalography. Manipulation of the apparatus requires the operator's entire attention. The practice, as advocated, of replacing a given volume of fluid by a smaller volume of air, is erroneous[31,32] and the volumes exchanged (2 to 3 c.c.) are so small as to unduly prolong the procedure. Abrahamson[1] has described a simple apparatus which is in effect a jar interposed between a bulb and the needle. It produces

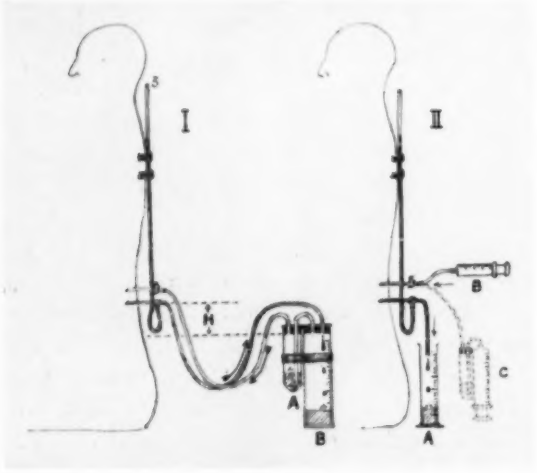

FIG. 1. Two simple methods for the simultaneous replacement of cerebrospinal fluid by a gas. *I.* Automatic type: *A.* Test tube water-bath containing hot sterile water through which all gas passes on its way to the subarachnoid from *B*, a 250 c.c. graduate into which the cerebrospinal fluid empties at a distance *H* below the lower needle. 3. An open-end 2 mm. bore cerebrospinal fluid manometer strapped with adhesive tape to patient's back and attached to the lower needle by means of rubber tubing and a 2-way stopcock. *II.* Syringe type in which the spinal fluid runs from the lower needle by way of a 2-way stopcock into a graduate *A*, while air is slowly introduced at the upper needle by a 50 or 100 c.c. syringe, *B*. The water bath (*AI*) may be interposed between syringe and needle if desired, as shown at *C*.

alternating pressures and supplies no means by which the pressure may be watched. Though providing for sterilization of the gas, it is subject to the general criticisms of any single needle apparatus.

Two lumbar punctures may be performed with but slightly more difficulty to operator or trauma to the patient. With two needles in place, one above the other, many modifications of the procedure are possible. The simplest is to leave both needles open to atmospheric pressure in order that fluid may run from the lower, while air enters at the upper needle. Both needles will at first discharge fluid and air will not enter the upper needle until the pressure at that point has fallen below atmospheric. Hence, an appreciable decrease of spinal fluid pressure (about 400 mm. water) must occur before replacement begins. Such a large decrease may cause serious complications.[23] Castex and Ontaneda[5a] have recently described a combined lumbar and cisternal method which maintains the intracranial pressure at or about atmospheric. Their method is to allow the lumbar fluid to drain into a closed bottle containing air adjusted to cisternal pressure at about atmospheric pressure which is displaced by the fluid from the bottle into the cranium through a needle inserted into the cisterna magna. It would have been simpler and equally efficient merely to insert a lumbar and cisternal needle into the subarachnoid. Fluid will run from the lower allowing air at atmospheric pressure to enter the upper needle. Because of the presence of a cisternal needle adequate cranial manipulation cannot be accomplished, without which the roentgenograms are invariably poorly filled (as in their illustration). Furthermore, in any of these methods, the resultant pressures must be atmospheric. Such a pressure with its smaller volume of air does not often produce reliable roentgenograms.[32]

An efficient simultaneous replacement method is shown in Figure 1, *II*. An attempt is made to maintain adequate pressure (150 mm.) during replacement by introducing gas at the upper needle with a syringe, while fluid is allowed to escape from the lower. The pressure is allowed to decrease slowly and constantly by introducing air so that the rate of exit of spinal fluid remains constant. The cerebrospinal fluid pressure may be varied at will. This

method requires the constant attention of the operator and entails manipulation of stopcocks. Room air must be used, but a sterile water-bath may be interposed between syringe and needle. This is the method of choice whenever an automatic replacement apparatus is unobtainable. All "simultaneous replacement" methods are modifications of this technique in order that replacement may be both aseptic and automatic.

(4) SIMULTANEOUS REPLACEMENT APPARATUS FOR ENCEPHALOGRAPHY

Several types of apparatus have been described by means of which the cerebrospinal fluid may be automatically replaced by gas. All of these depend upon the use of two lumbar puncture needles or of a double needle, as described by Liberson.[20] The principle of any simultaneous replacement apparatus is quite simple (Fig. 1, *I*). Spinal fluid drains from the lower lumbar puncture needle by tubing through one of two openings into an otherwise closed bottle. This fluid displaces an equivalent volume of gas from the bottle through the other opening, and from it to the upper needle into the subarachnoid. The most recent of these is the combined cisternal-lumbar replacement method of Castex and Ontaneda[5a] which was described under the previous heading.

I have experimented with several simultaneous replacement methods and have found that the seemingly simpler pieces of apparatus do not control the variations which occur in individual cases. However, one of the most useful consists of a graduate and test tube bound together with adhesive tape (Fig. 1, *I*). Each is closed by a rubber stopper containing two holes. Glass and rubber tubing connections are used as shown in the figure. The test tube is used as a water-bath, and the entire apparatus is connected to the puncture needles by small bore rubber tubing. The rate of flow of gas into the upper needle may be regulated by the position of the graduate relative to the lower puncture needle. The cerebrospinal fluid pressure is measured by an open end manometer of less than 2 mm. bore attached by rubber tubing to the lower needle. This manometer is strapped to the patient's back with adhesive tape. A 2- or 3-way valve is used at the lower needle, thus connecting either cylinder or manometer with the subarachnoid. Such an apparatus must be sealed (paraffin) each time it is used. Furthermore, it does not allow of the introduction of the extra volume of gas necessary to maintain an adequate final subarachnoid pressure. Manipulation of the valve at the lower needle is necessary before reading the spinal fluid pressure. The manometer and its tubing should be filled with sterile water or saline before attachment to the needle. This apparatus is similar to Liberson's,[20] but with the cylinder inlet at the top of the graduate, a spinal fluid manometer at the lumbar level and an added water-bath. For those who desire further simplification, the double needle constant replacement method (Fig. 1, *II*) is recommended as has been described.

Liberson[20] has described an apparatus which is of distinct value, especially when used with his double needle. Several criticisms may be offered, however. The bottle would appear difficult to clean and sterilize. The attachment of a mercury manometer to the spinal fluid outlet tube is awkward and inaccurate. Variations in pressure or volume of gas and fluid cannot be accomplished either with ease or accuracy. In his description, the author recommends that the apparatus be used so as to maintain the original cerebrospinal fluid pressure. If, as is advised, all or most of the cerebrospinal fluid were replaced by gas, maintenance of the original pressure would increase the intracranial pressure from subatmospheric (-150 mm.) to a positive pressure of 450 mm. of water, a total increase of 600 mm.[32] This pressure is much too great for safety.

Piercy[26] recently demonstrated a modification of Liberson's apparatus which is compact, airtight, and easily cleaned.

Again the use of a mercury manometer introduces errors and registers the lumbar spinal fluid pressure only when the outlet of the bottle is level with the lumbar needle. At this level the apparatus will cease to function. When the apparatus is placed below the lumbar needle in order that replacement shall occur, this distance *H* must be subtracted from the mercury manometer reading in order to give the spinal fluid pressure. The complexity of this process is unnecessary.

(5) MEASUREMENT OF CEREBROSPINAL FLUID PRESSURE

As one object of encephalography is to replace the intracranial spinal fluid with as little disturbance as possible of normal form and function, frequent pressure observations are necessary. Hence, it is important that the method of measuring pressure be accurate. The true or "initial" cerebrospinal fluid pressure may be measured only at the site of puncture with little or no displacement of spinal fluid. This

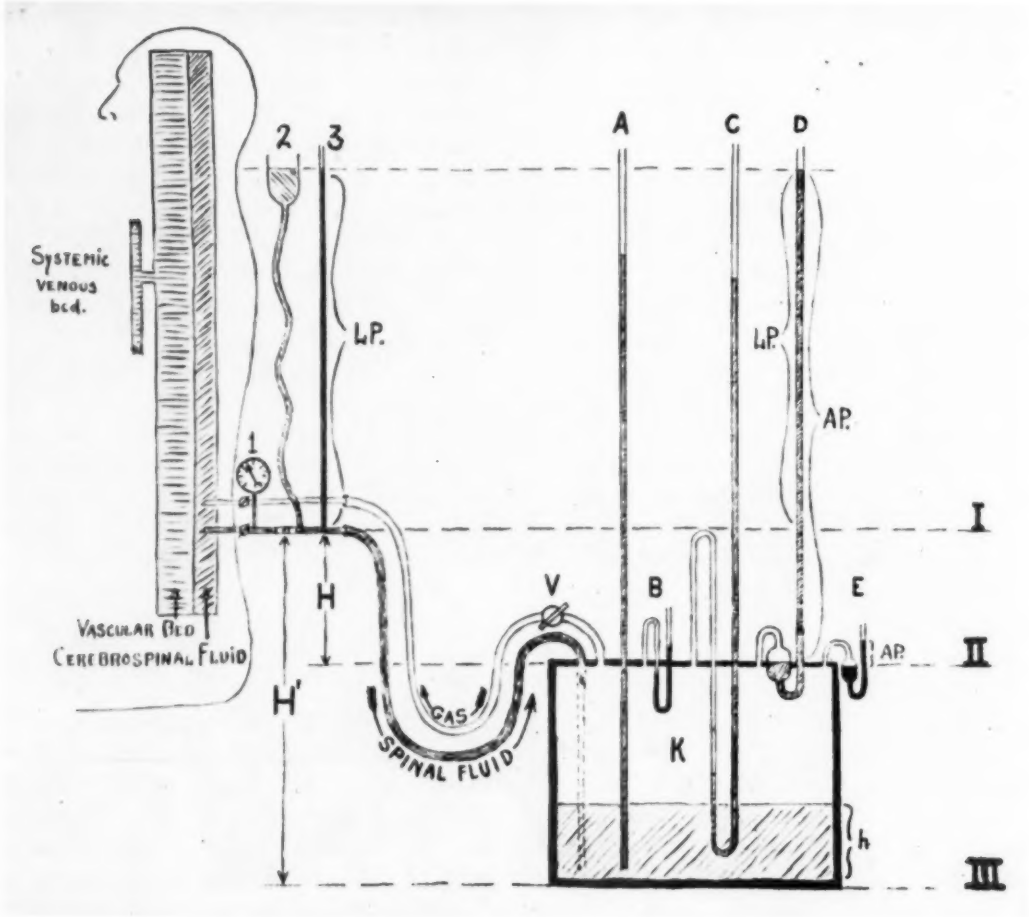

FIG. 2. Diagram illustrating the proper use of various manometers during encephalography. 1, a pressure gauge not displacing spinal fluid; 2, a bubble manometer not displacing spinal fluid (Weed); 3, an open-end 2 mm. bore spinal fluid manometer; *A*, 2 mm. bore open-end spinal fluid manometer; *B*, U-type mercury manometer; *C*, U-type 2 mm. bore open-end water manometer; *D*, barometric type 2 mm. bore open-end water manometer; *E*, barometric type open-end mercury manometer; *K*, closed container from which gas is replaced by spinal fluid; *V*, outlet stopcock; *H*, vertical distance between lower lumbar needle and the spinal fluid inlet into *K*; *H'*, vertical distance between lower lumbar needle and the spinal fluid inlet into *K*, if the inlet were extended to the bottom of *K* (dotted lines). For *I*, *II*, *III* *AP* and *LP* see text.

may be done with a non-displacement pressure gauge or "bubble-manometer,"[35] or with an open end manometer of less than 2 mm. bore.[35] (See 1, 2 and 3, Fig. 2.) After connection of the needle with any replacement apparatus enough fluid is displaced to lower appreciably the initial pressure. Therefore, manometers or gauges attached to an apparatus do not measure the initial cerebrospinal fluid pressure. This pressure is, however, only of academic interest, as in most cases the pressure after attachment of the apparatus may be used as a starting point for further observations. In order to measure the cerebrospinal fluid pressure at any time, an equilibrium between gas and fluid pressure must be reached. The cerebrospinal fluid pressure cannot be determined accurately *during* the actual replacement of spinal fluid by gas, but only after the flow of fluid and gas has ceased. This is accomplished by shutting off the flow of gas and waiting until the flow of fluid ceases. At this point, equilibrium is reached and the pressure may be read. During the replacement of cerebrospinal fluid, the pressure measured in an apparatus (Fig. 2, *K*) approximates the cerebrospinal fluid pressure only if the flow is unimpeded. However, the pressure in an apparatus during replacement may be taken as a rough estimate of the lumbar cerebrospinal fluid pressure.

In any closed "simultaneous replacement" method the gas must overcome certain forces before it may enter the subarachnoid space. One is due to the friction and surface tension in the needles and tubing, another to the pressure of the cerebrospinal fluid at the point of entry of the gas. Hence, the gas must be at a pressure somewhat greater than that of the cerebrospinal fluid at the point of entry. Theoretically, the difference between the cerebrospinal fluid pressure at the outlet needle and that at the inlet needle which is several centimeters higher should be sufficient to maintain a flow. Actually, this is not the case. It is usually necessary to place the outlet of the spinal fluid (its point of entry into the bottle) 100 to 150 mm. below the lumbar needle. This means that the pressure in the bottle is greater than the cerebrospinal fluid pressure. This is equivalent to the vertical distance between the outlet of fluid into the bottle and the lumbar needle outlet. Accordingly, this distance must be taken into account when measuring the spinal fluid pressure (Fig. 2, *H*).

The various types of manometers in use may be compared by reference to Figure 2. This demonstrates limitations and correct use of each type.

Let LP = the cerebrospinal fluid pressure at the lower lumbar needle; per ex 400 mm. of water.

Let AP = the pressure of the air in the container, *K*.

Let H = the vertical distance between the lumbar needle and the inlet of the spinal fluid into the container, per ex 100 mm.

Let H' = the same distance if the inlet be extended to the bottom of the container (dotted lines) per ex 250 mm.

Let h = the height of the spinal fluid collected in *K*, per ex 50 mm.

Suppose the "initial" cerebrospinal fluid pressure at the lumbar region (with patient sitting) to be 450 mm. of water as measured by: (1) gauge, (2) non-displacement bubble manometer, or (3) open-end manometer of less than 2 mm. bore. Suppose the container to have been opened to atmospheric pressure, then connected to the lumbar needles. The system is now closed from the atmosphere. Suppose valve *V* to be closed. Suppose the system to be in equilibrium, spinal fluid having drained into the container, reducing the initial LP from 450 to 400 mm. of water. Henceforth, LP will be considered as 400 mm. of water.

A is a spinal fluid open-end manometer of 2 mm. bore; *B*, a U-type open-end mercury manometer; *C*, a U-type open-end water manometer; *D*, a barometric type water manometer; *E*, a barometric type mercury manometer.

If the container be raised so that its top (level *II*) be flush with level *I* then at equilibrium *AP* equals *LP* and the cerebrospinal fluid pressure may be measured directly in all the manometers. *B* and *E* will record in millimeters of mercury (29.4 mm.), *C* and *D* in millimeters of water, and *A* in millimeters of spinal fluid if measured upwards from the fluid level of *h*. This may be done only when the inlet of the spinal fluid into the container is level with the lumbar needle.

As has been pointed out, when the apparatus is in use, it must be some distance (*H*) below the lumbar needle, for example, 100 mm. At this level (*II*) *AP* (which is equal to *LP*+*H*) will be recorded directly by manometers *B*, *C*, *D*, and *E*. *A* will record *AP* if measured from the upper level of the fluid (*h*). *LP*, not *AP*, is the important pressure, and in order to obtain *LP*, *H* must be subtracted from the readings observed in the manometers. This may be done readily in the case of *A*, *C* and *D*. As *H* is equivalent to millimeters of water, while *B* and *E* record in millimeters of mercury, a cumbersome and often inaccurate calculation must be made transforming millimeters of mercury (specific gravity 13.6) to millimeters of water.

The mercury manometer may be calibrated in millimeters of water thus saving such calculation. However, the large range of error in such manometers when measuring small pressure increments more than outweighs the convenience of handling a small instrument. Several types of mercury manometers were thoroughly tested in conjunction with encephalographic apparatus. Finally, all were discarded because of their errors and the difficulty with which accurate observations were made.

If the inlet of the container be extended (dotted lines) to the bottom of the container (level *III*) the meniscus of *A* will always be level with that of *3*, as was the case for *D* when the inlet opened at level *II*. *A* will then directly record *LP* when level *III* is flush with level *I*, while the other manometers will record *AP* which is then equal to *LP*−*h*. When on level *III*, *A* will record *LP*+*H'*, while the others will record *LP* as equal to *AP*+*h*−*H'*.

It would then appear that with the inlet opening at the top of the container, the manometers of real value are *C*, *D* and *E* when the apparatus is operating as shown at level *II*. When the inlet is extended to the bottom of the container, the only manometer of any use is *B*. As a general rule U-type manometers (*B* and *C*) are less easily read than single arm types (*A*, *D* and *E*). Water (*C* and *D*) or spinal fluid (*A*) manometers are cumbersome, and easily broken. The mercury types (*B* and *E*) do not readily show significant changes in pressure; for example, 50 mm. of water is but 3.6 mm. of mercury. They often show more than a 20 per cent error. The necessary computations involved when *H* must be subtracted from *AP* makes their use most inconvenient and inaccurate because of the necessary change of millimeters of mercury (specific gravity 13.6) to millimeters of water. The mercury manometer may be used with some degree of ease and accuracy only in the barometric form (*E*), not in direct contact with spinal fluid, and only at the level of the subarachnoid puncture. The spinal fluid manometer *B* is cumbersome and fragile, and may be accurately used only when the inlet of the container extends to the bottom. *C* presents all the difficulties of a large fragile U-manometer. *D* is most practical, but somewhat cumbersome. If a marker be placed on the manometer level with the lumbar needle, the height of the column of water above is always equivalent to the cerebrospinal fluid pressure at the lumbar needle.

It would appear, therefore, that the cerebrospinal fluid pressure may be most easily, accurately, and conveniently measured by a 2 mm. bore open-end manometer at the site of puncture (Fig. 2, 3), or by barometric type water manometer attached to the apparatus (Fig. 2, *D* and Fig. 3).

(6) A NEW SIMULTANEOUS REPLACEMENT APPARATUS

A new apparatus has been constructed for encephalography. The purpose of this apparatus is to provide for the adequately controlled automatic replacement of cerebrospinal fluid by air or other gas. The seeming complexity of the apparatus itself is more than balanced by the ease of operation and the results obtained. To be of value, such an apparatus must give the operator an accurate conception of the dynamic changes taking place during encephalography. It must be readily sterilized, compact, easy to operate, and relatively "fool-proof." Finally, it should improve the roentgenographic results while minimizing the patient's reaction, during and subsequent to encephalography.

The apparatus (see Figs. 4 and 5) is essentially an airtight container (*B*) to which is attached a water-bath (*A*), a barometric type water manometer (*D*) and a 20 c.c. syringe (*C*). It consists of a 300 c.c. pyrex glass cylinder graduated to 2 c.c. volumes. This is fitted with an airtight stopper pierced by an inlet and outlet tube. Around the bottle neck is a metal band which supports on one side a 20 c.c. syringe (*C*), and on the other, a 20 c.c. water-bath (*A*), both of which are removable. The inlet tube is fitted with a 3-way valve (*E*) connecting the lumbar puncture needle with the atmosphere (position 1) or with the bottle (position 2); or connecting the bottle with the atmosphere (position 3). The outlet tube is fitted with a 4-way valve (*F*). This connects the bottle with the syringe (position 1), the bottle with the water-bath and outlet (position 2) and the syringe with the outlet (position 3). In all these positions, the manometer remains connected with the bottle, outlet or both.

The inlet is connected with the lower of two lumbar puncture needles, the outlet with the upper. If a double needle is used, Either connection may be utilized. Equal lengths of small bore soft rubber tubing are used to connect the apparatus with the needles.

The entire apparatus is detachably mounted on a small wooden base. The barometric type water manometer is also detachably mounted on the base. If a pointer is placed on the manometer at a level with the lower lumbar needle, both gas and cerebrospinal fluid pressure may be easily observed. The gas pressure (in the cylinder) is shown by the entire column of water supported in the manometer while the height of the column above the pointer

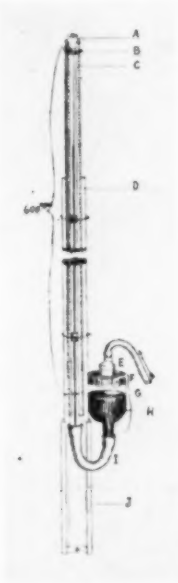

Fig. 3. Diagram of barometric type open-end water manometer. *A*, 500 or 600 mm. open-end glass tube with 2 mm. bore; *B*, copper-wire ring securing glass tube inside half open metal tube *C* from which it is separated by a section of rubber tubing; *D*, flat grooved metal rod (flat sliding curtain rod) supporting *A* and *C*. This slides removably into a small section of larger size (curtain) rod *J* which is screwed to the base; *E*, glass cannula attaching a tube from the large bottle (*B*, Fig. 2) through rubber stopper *F* to *G*, a 5 to 10 c.c. glass reservoir filled with colored water *H* and attached by rubber tubing *I* to glass manometer tube *A*. Pressure alterations transmitted to the manometer via *E* produce less than 2 mm. lowering of the fluid in *G* for 600 mm. elevation of the meniscus in *A*. Pressures may thus be directly measured in *A* as mm. of water.

is a measure of the cerebrospinal fluid pressure at the lumbar needle. The entire apparatus is compact, stable and subject to minimum breakage.

In order to eliminate the necessity for two needles and two lumbar punctures, a double needle has been designed (Fig. 6). This is less expensive and more practical than that described by Liberson.[20] It consists of two 20 gauge 10 cm. flexible needles with german-silver stylettes soldered parallel to each other. The tips are bevelled to a single point and the hubs are curved slightly to right and left respectively. Adapters, valves or stopcocks may thus be inserted in both needles with ease.

The following technique has been found most efficient. The entire apparatus with the exception of the base may be autoclaved as a unit or the water-bath containing 3–5 c.c. of water may be boiled with the lumbar puncture kit (Fig. 6). The former procedure is used only in septic cases; the latter is usual. In this case, the water-bath

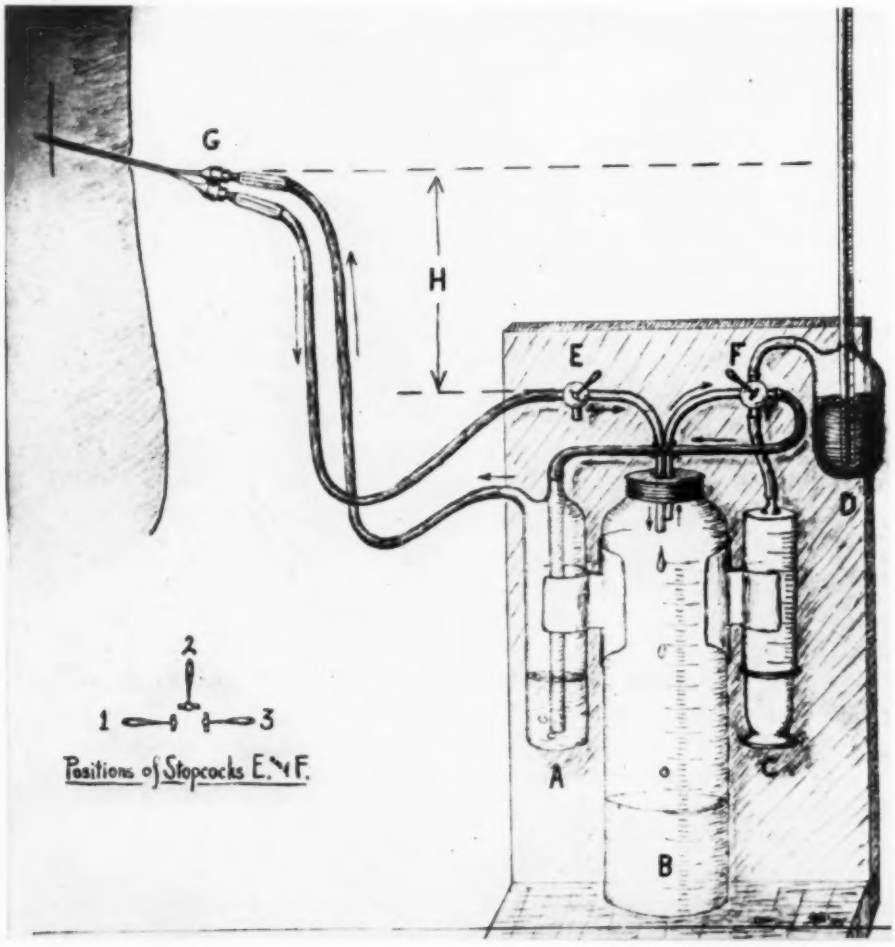

FIG. 4. Diagram of an apparatus for the automatic simultaneous replacement of cerebrospinal fluid by gas. *A*, detachable pyrex water-bath containing 5 c.c. of hot sterile water and a sterile cotton plug at outlet; *B*, graduated 250 c.c. pyrex bottle with airtight metal top; *C*, pyrex 20 c.c. oiled syringe; *D*, barometric type open-end 2 mm. bore water manometer; *E*, 3-way stopcock at inlet connecting: in position 1, inlet with the room air; in position 2, inlet with the bottle; in position 3, bottle with the room air; *F*, 4-way stopcock at outlet connecting: in position 1, bottle, syringe and manometer; in position 2, bottle, outlet and manometer; in position 3, syringe, outlet and manometer; *G*, double lumbar puncture needle with glass cannulae inserted; *H*, the vertical distance between the lumbar puncture needle and the inlet to the bottle. The arrows depict the direction of flow. Both stopcocks are shut off.

is attached to the apparatus, care being taken to maintain the sterility of the adapter. The patient is placed in the sitting position for puncture and the operator dons sterile gloves. Lumbar puncture is then performed. The double needle or needles are then connected to the apparatus by means of sections of rubber tubing. The lower needle is connected with the inlet valve (*E*) which is then shut off. The upper needle is connected with the outlet from the water-bath and the outlet valve is also shut off. The subarachnoid is now closed to any contamination and the operator may remove his sterile gloves. The apparatus is so placed that the spinal fluid inlet (*E*) is about 100–150 mm. below the lower lumbar needle. This distance is *H*. Therefore, the pointer on the manometer is placed at *H* mm. above the zero point, that is, level with the lumbar puncture needle. The handles of both valves are now pointed towards each other so that valve *E* is in position 3 and valve *F* in position 1. About 20 c.c. of air is then drawn into the syringe. Valve *E* is now turned to position 2 and air is forced from the syringe into the bottle until about 400 mm. pressure registers in the manometer (*D*). By varying the pressure on the syringe, the flow of fluid into the bottle via *E* may be just prevented. At this point the manometer registers the lumbar cerebrospinal fluid pressure and the air pressure in the bottle. The cerebrospinal fluid pressure is indicated by the height of the column of fluid in the manometer above the marker placed on a level with the needle while the pressure in the bottle is indicated by the entire column above the zero point.

Stopcock *F* is now turned slowly up to position 2. Both stopcocks are now in position so that fluid will run from and air into the subarachnoid. The pressure registered in the manometer will approximate the lumbar cerebrospinal fluid pressure. More accurate determination of this pressure may be made by returning the stopcock *F* to position 1, holding the plunger of the syringe in place. Should fluid return through the outlet tube attached to the water-bath, it may be forced out by pressure on the syringe with the stopcock *F* in position 3. Samples of fluid may be collected from time to time by turning *E* into position 1. After adjustment of the apparatus, the operator attends to the manipulation of the patient's head. He observes the pressures and occasionally measures the lumbar subarachnoid pressure by shutting

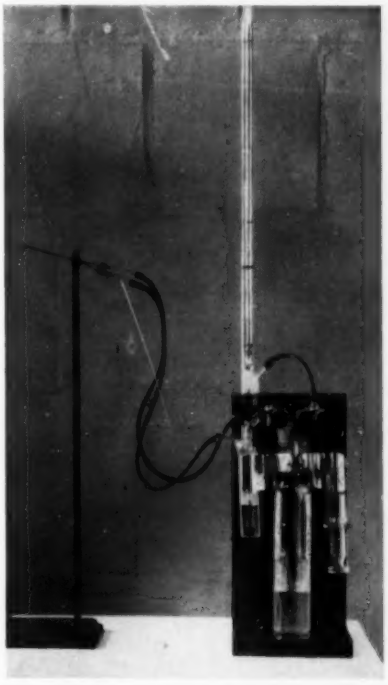

Fig. 5. Photograph of apparatus described in the text.

off the outlet valve and reading the cerebrospinal fluid pressure when the fluid ceases to flow into the cylinder. The gas thus constantly enters the subarachnoid with a minimum pressure change. The gas that enters has been passed through the hot sterile water-bath and is hence less likely to produce untoward reactions.[32] The syringe and stopcocks provide for any necessary or experimental changes in volumes, pressures or character of the gas introduced. Any gas may be introduced at any time by attaching the free outlet of the 3-way valve (*E*) to a gas chamber. By use of the syringe, measured volumes of gas

may be introduced or removed from the cylinder at will, and the pressure may be varied as desired. In case of sudden untoward increase in spinal fluid pressure, the apparatus may be instantly opened to atmospheric pressure by the 3-way valve (*E*). The rate of introduction of gas may be regulated by the outlet valve. Such gas has been warmed by passing through the warm sterile water-bath and is hence less apt to expand at body temperature. If necessary, a thermometer may be attached at the water-bath to measure the temperature of the gas introduced. Sterile samples of cerebrospinal fluid may be obtained at intervals during encephalography by way of the inlet valve or fluid may be withdrawn outside the container or other fluid introduced.

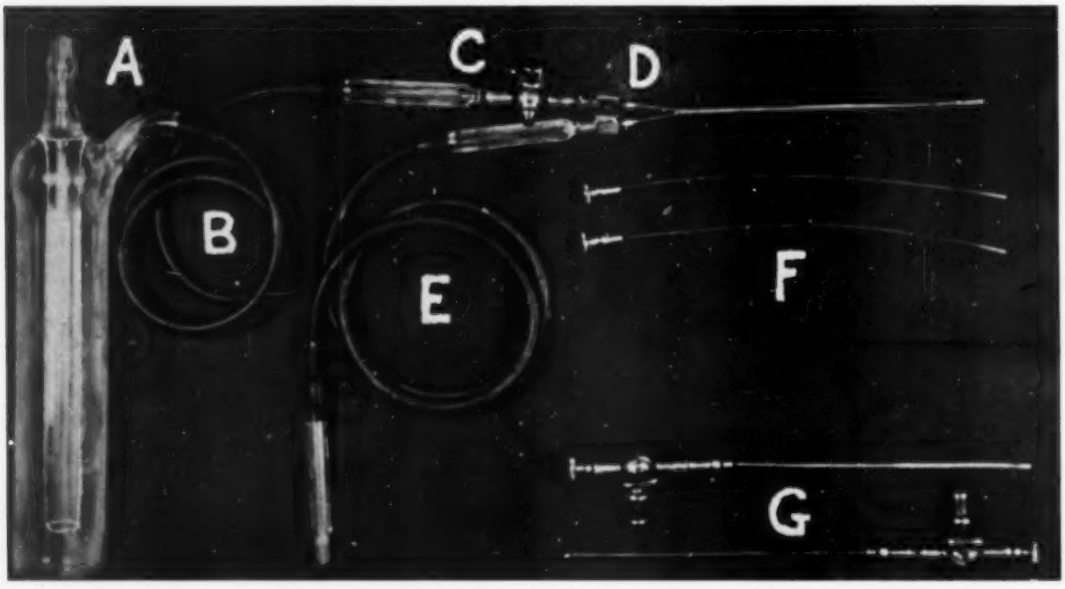

FIG. 6. Parts of the apparatus which are sterilized by boiling. Pyrex water-bath (*A*), with rubber tubing and glass adapter (*B*), inserted into three-way stopcock (*C*), in turn inserted into one of the hubs of a double needle (*D*). Small bore rubber tubing (*E*), with glass adapters to conduct fluid from the needle to the apparatus. The encephalography needle is a 10 cm., 20 gauge, double-barrel needle with tips bevelled to a common point. It is made of flexible material and the hubs are somewhat divergent for the accommodation of adapters and stopcocks. The stylettes (*F*) have been removed and the needle assembled as for use. If this needle is not available, two Fremont-Smith lumbar puncture needles may be used (*G*).

(7) SUGGESTED STANDARD TECHNIQUE FOR ENCEPHALOGRAPHY

There are so many variations in the method of performing encephalography that comparison of a series of encephalograms is most misleading. Even when performed by the same person on the same patient, these differences detract from the accuracy with which the encephalograms may be compared with each other. Attempts have been made to standardize encephalographic procedure. Until this is accomplished comparisons of encephalograms will be misleading, especially with respect to degree of atrophy depicted. The following technique is suggested as combining the best features of various procedures in use in several clinics.

A lumbar puncture and studies of the cerebrospinal fluid dynamics, cytology, serology and chemistry should always precede encephalography. The information thus obtained may contraindicate encephalography and if not, is of immense value in interpreting the encephalographic observations. It is furthermore essential to obtain the cerebrospinal fluid pressure at the lumbar sac while the patient is recumbent.

Anesthesia or deep narcosis is a boon to both patient and operator. Ether is to be avoided because of its untoward effect upon the intracranial dynamics; neither is nitrous oxide[37] advised because of the immense increase in blood pressure and spinal fluid pressure produced by it. Avertin, amytal and many others have been found effective.[5,7,16,25,28,34] The non-volatile narcotics are especially efficient in alleviating the patient's subsequent reaction, as well as producing deep narcosis.[28] Morphine gr. $\frac{1}{8}$ to $\frac{1}{6}$ followed by from 0.3 to 0.5 gm. of sodium pentobarbital (nembutal) intravenously is recommended. The rate of injection of nembutal must be very slow, and the amount used depends solely on the patient's reaction to the anesthetic.

The barbiturates (avertin, amytal, nembutal, etc.) are unfortunately of little value as anesthetics in cases which have been treated with phenobarbital or bromides for some time. It has been found that many of the "epileptics" so treated are very refractory to such anesthetics. In these and other selected cases, morphine and scopolamine narcosis is advised. About 1/120 grain of scopolamine hydrobromide is given subcutaneously two hours previous to encephalography followed by $\frac{1}{8}$ to $\frac{1}{6}$ grain of morphine sulphate intramuscularly thirty to twenty minutes before encephalography.

The best approach to the subarachnoid is by way of the lumbar route, and the use of two lumbar puncture or of a double needle is advocated. The use of the automatic simultaneous methods is also recommended. The operator is then free to manipulate the patient's head during replacement. If the apparatus shown in Figure 4 is not available, the syringe method of simultaneous replacement is advised (Fig. 2, *II*), or a simplified automatic replacement apparatus may be used (Fig. 2, *I*).

Many gases have been used to replace cerebrospinal fluid, such as nitrogen, helium, carbon dioxide and oxygen.[3,14,21,30] Air, however, will probably remain the most widely used. It is recommended that the air be filtered through hot sterile water as such a procedure minimizes the patient's subsequent reactions.[21,32]

The amount of gas used is a variable dependent upon intracranial form and function, and hence cannot be standardized. The amounts used should depend solely upon the pressures produced.[25,31]

A minimum variation of pressure is desirable. This minimum is maintained by the simultaneous replacement method. No attempt should be made to maintain a final subarachnoid pressure equal to the original cerebrospinal fluid pressure at the lumbar sac.[20,34] Maintenance of such an "erect lumbar pressure" produces dangerously high intracranial pressure. Neither should the subarachnoid pressure at the lumbar sac be allowed to reach atmospheric pressure at the completion of encephalography. Enough gas should be introduced to maintain the final subarachnoid pressure at the lumbar sac about equal to the original lumbar cerebrospinal fluid pressure for that patient, measured in the *recumbent* position. Thus the normal intracranial pressure is resumed when the patient is returned to bed; his reaction is less severe and the roentgenograms are more accurate. The pressures may thus be standardized for any patient if the final subarachnoid pressure at the lumbar sac, measured in the sitting position, be made equal to the same pressure previously measured in the recumbent position.

During the replacement of spinal fluid by air, the patient should be maintained in an erect sitting position. This predisposes to an even distribution of the gas in the intracranial spaces. The use of some chair-like supportive apparatus is an invaluable aid in maintaining this position, especially in narcotized patients.[17]

During replacement the patient's head should be tilted slowly forward and back by the operator in order to replace the ventricular and subarachnoid fluid as completely as possible. This is especially important in demonstrating the temporal horns. The erect position drains the third, fourth, and the anterior horns of the lateral

ventricles, antero-flexion predisposes to cortical and subtentorial replacement, while postero-flexion drains the fluid from the cortex and basilar cistern. Lateral flexion is to be avoided since it may result in an asymmetrical accumulation of air. All movements should be slow and even as cranial manipulation during encephalography is in effect a massage of the relatively "dry" brain.

The patient should be maintained erect with as little manipulation as possible from the moment the injection of air is begun until the roentgenograms are taken. Right and left lateral stereoscopic exposures should be taken with the patient in the erect position. Anteroposterior stereoscopic views are usually of more value than "flat" anteroposterior and posteroanterior views. An apparatus has recently been described which greatly facilitates the roentgenographic technique.[17] In certain cases it is important to demonstrate the occipital or temporal horns. It is then necessary to take lateral and posteroanterior exposures with the patient recumbent. These should be made *after* the erect pictures have been taken.

CONCLUSIONS

Encephalography is becoming an increasingly important aid to neurologic diagnosis. Numerous variations of encephalographic technique have been described and several types of apparatus have been suggested. Little attention, however, has been paid to the fundamental dynamic changes occurring during encephalography. These dynamics are of vital importance in controlling both the reaction of the patient, and the roentgenographic results. All methods and pieces of apparatus should be based upon these dynamic principles.

The hydrodynamics of encephalography are briefly outlined. The use of various types of manometers is discussed in some detail. Various methods of encephalography are outlined and several of the more important pieces of apparatus critically discussed. As clinical and roentgenographic evidence from this and many another clinic has suggested the value of certain encephalographic procedures, a technique is suggested in the hope of standardizing encephalography.

1. Encephalography should be preceded by a lumbar puncture (with complete spinal fluid study) performed with the patient recumbent.

2. Anesthesia or deep narcosis is advised.

3. Lumbar puncture is the safest and most efficient portal of entry to the subarachnoid space, while the use of two lumbar punctures is preferable to a single puncture, except where technically impractical as in the case of infants. The double needle is the instrument of choice.

4. The automatic replacement method is advocated, or at least such a method as will produce the minimum alternate variation in subarachnoid pressure.

5. The gas of choice is air filtered through hot sterile water. The volume of gas used should depend solely upon the resultant pressures, while the rate of introduction should be as slow as possible without unduly prolonging the procedure.

6. Lumbar subarachnoid pressures should be measured frequently and allowed to progressively decrease to a figure about equal to the same pressure as recorded with the patient recumbent (average 150 mm. of water). This will usually require the introduction of a volume of gas greater than the volume of fluid replaced.

7. All obtainable cerebrospinal fluid should be replaced by gas.

8. The patient should be kept in a sitting position throughout the entire replacement. The use of a supporting apparatus is advocated.

9. During replacement the patient's head should be tilted slowly forward and back.

10. The patient should be maintained erect until the routine roentgenograms have been made. Subsequent roentgenography while the patient is recumbent is indicated in certain cases.

An apparatus is described which has been found to facilitate the technique, minimize the patient's reaction, increase the reliability of the roentgenograms, and provide control of the various dynamic factors occurring during encephalography. The apparatus is compact, sturdy and reliable. It may be boiled or autoclaved in part or as a unit. It may be used with any gas at reasonable pressures. Such gas is passed through a sterile water-bath. Simultaneous readings may be made of the cerebrospinal fluid pressure and the pressure at which the gas enters the subarachnoid. Changes in volume, pressure or type of gas may be effected during encephalography. The temperature of the gas may be recorded if essential.

As alternatives two other methods are suggested based upon the same principles as the method and apparatus described.

The value of any method or apparatus depends not so much upon its construction as upon its proper use, which in turn depends upon a knowledge of the dynamic changes taking place during encephalography.

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A TECHNIQUE FOR ROENTGEN IRRADIATION OF INACCESSIBLE CANCER OF THE SKIN*

By HOWARD HICKS ASHBURY, B.S., M.D.
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THE technical difficulties in the treatment of cancer of the skin are usually not so complicated as in deeply situated lesions. The more common methods of treatment include surgical excision, electrocoagulation or desiccation, caustic pastes, roentgen rays, radium or radon plaques, gold tubes containing radon, surface applicators containing radium or radon, bulbs containing unfiltered radon, and radium element needles for interstitial use. Each of these methods is at some time more desirable than the rest, but the method of choice in treating superficial lesions will yield more gratifying results if the mode of therapy is carefully selected. Basal cell epithelioma near the eye, particularly at the inner canthus, has long been a difficult problem. There are two reasons for this. First, the irregular contour of the region does not lend itself readily to the use of radium plaques or applicators for the depressions receive less radiation than the elevated portions of the skin, causing an uneven distribution of radiation. This may be illustrated by the fact that, using a radium or radon plaque at a distance of 1 cm. from the skin, a variation of 2 mm. in the skin-radium distance will change the dosage over 30 per cent. The second difficulty in irradiating this region lies in the radiosensitivity of the normal structures near the inner canthus of the eye. The eyeball as a whole is not markedly sensitive to irradiation, but cataract, in some cases, may be a later complication. Acute glaucoma has been noted following irradiation,[1] and I have seen the condition in a patient who was irradiated for an extensive adenoid cystic epithelioma about the eye. This patient had been ineffectively treated for several years with small amounts of radium at varying skin distances and with varying filters. In an effort to control the active disease still present another radiologist treated the lesion with divided doses of roentgen rays. The roentgen treatment also failed to control the disease. When the patient was seen by the author eight months after his last radiation treatment there was a typical acute glaucoma present.

The ocular and palpebral conjunctivae are quite radiosensitive and adequate radiation to these structures will cause a painful acute conjunctivitis which, although transient, is frequently followed by chronic dryness and irritation, with epilation of the eyelashes.

In order to overcome these difficulties efforts have been made to confine the radiation, as nearly as possible, to the lesion and avoid treating the normal structures. Lead or gold shields which are placed in the conjunctival sac have been used in conjunction with radium plaques for treating epitheliomas about the eyes and lids. The disadvantages of this method are that a sufficient thickness of gold or lead is most difficult to use and that the lids are not protected at all. Martin[2] has obtained some excellent results by imbedding gold radon tubes in the lesion. By this method, as compared to the use of radium or radon plaques at 1 cm. distance from the skin (filter 2 mm. brass), the lens receives 10 per cent of the total radiation against 30 per cent and the conjunctiva 40 per cent against 60 per cent. Inspection of these figures will show, that, if the lesion to be treated is of sufficient size to require more than a minimal dose of radiation, the normal structures will absorb an appreciable

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[2] Martin, H. E. Radiation therapy in skin cancer. *Am. J. Cancer*, 1933, *19*, 605–621.

* From The Nassau County Tumor Clinic, Farmingdale, N. Y.

FIG. 1. Type of lesion suitable for this form of treatment. Note that the basal cell epithelioma extends to within a millimeter of the mucocutaneous junction of the eyelid.

amount of radiant energy. In addition gold tubes are sometimes difficult to obtain and are often uneconomical.

Faced with this difficulty in treating indigent patients in a clinic not routinely supplied with gold tubes, I have devised a method for protecting the normal structures of the eye and treating the lesion with low voltage roentgen rays. The basic principle followed in the treatment of these lesions is the same as that used in the roentgen treatment of basal cell epithelioma in other portions of the skin, namely, the administration of a lethal dose of roentgen rays to the lesion at one sitting. The factors of treatment generally used are: 140 kv., 20–35 cm. target-skin distance, 1–2 mm. of aluminum or no filter and 2,000–3,000 r. In giving such caustic doses it is imperative that the lesion be very exactly outlined by lead or some other substance which will act as a barrier to the rays. Due to the irregular contour of the anatomy around the inner canthus of the eye, this is extremely difficult to do with precision. The following technique was evolved to overcome this difficulty.

If necessary, scabs or crusts are removed from the involved area, and the lesion, eyebrows, eyelashes, and surrounding areas are coated with vaseline. A small handful of dental compound is made malleable in hot water and an impression taken of the lesion and surrounding areas, care being taken that the impression takes in the entire eye. After the compound has hardened,

FIG. 2. The dental compound impression being held in place after it has hardened.

sheet lead, 1/16 inch thick, is moulded against the inner surface of the impression. This can be facilitated by using the rounded handle of a pair of scissors or a surgical clamp. This lead lining when lifted off the impression is a mask of that part of the face under consideration. With the aid of a pair of sharp pointed scissors a hole is cut through this lead mask to very exactly outline the field through which the lesion will be treated. Any rough edges or delicate enlargement of the field can be taken care

FIG. 3. The dental compound impression and lead sheeting shown together after the lead has been moulded against the impression.

Fig. 4. The lead shield being held in approximate position. The small port has been cut through the lead sheeting. For convenience in taping the shield in exact position the excess edges of the shield may be trimmed away.

Fig. 5. Five weeks after treatment. Complete healing has taken place and none of the original disease can be detected. This patient received 2,000 r of unfiltered roentgen rays, 140 kv. at 35 cm. target-skin distance.

of with a small file. A thin coating of paraffin is applied to the under surface of the mask immediately around the edges of the port in order to absorb any soft scattered radiation from the lead. The shield is ready for use. It is held securely in place with adhesive tape and the roentgen treatment given. The shield is easily tolerated by the patient during the period of treatment. The accompanying photographs illustrate the steps in the preparation of the shield.

Three patients have been treated by this method with gratifying results. All three of these patients had basal cell epithelioma of the inner canthus of the eye. There was complete primary regression of the disease in all the patients and in none were there any untoward objective or subjective symptoms in the normal structures surrounding the lesions. It is suggested that this method of obtaining small exact fields can be applied to other regions, such as the nasolabial fold, or for the treatment of keloids where a cosmetic result is desired, the radiation being confined entirely to the lesion, leaving the normal surrounding skin unblemished.

The advantages of this method are that an adequate field and maximum protection to the surrounding normal tissues are efficiently provided. Besides the method is economical. The method is not excessively time consuming, but the preparation of such a shield as has been described is a relatively delicate procedure and it should be carried out with care.

SUMMARY

An efficient method for the production of very exact fields to be used in the roentgen treatment of basal cell epithelioma of the skin is described. The method is particularly useful in the treatment of malignant lesions of the inner canthus of the eye.

THE SEPARATE AND COMBINED USE OF ARTIFICIALLY AND NATURALLY PRODUCED RAYS*

By WILLIAM H. CAMERON, M.D.
NEW YORK CITY

MEMBERS and Guests of the American Radium Society: To be presiding officer of the Twentieth Annual Meeting is an honor I deeply appreciate and I take this opportunity to thank the officers and members of various committees for their warm support; to extend the courtesies of debate to our guests; to report on the affairs of the Society and to make a few suggestions in respect to the separate and combined use of artifically and naturally produced rays.

The ordinary affairs of the Society have moved along with their usual smoothness. I understand, however, that there is considerable dissatisfaction with the plan whereby physicians desiring to enter any branch of the radiological field must prove, to a representative body, their ability to use all recognized forms of radiation.

The intent of this plan is admirable, and, yet, before certain well established practices are cast aside and before it is decided whether or not there exists a ray interdependence, certain professional and technical factors must be considered.

In the first place, a member of the profession might well ask, Upon what foundation is a radiological practice constructed and what constitutes sound radiological judgment? Speaking from the standpoint of a radium therapist, my answer would be:

The American Radium Society was founded with the idea that membership would be open to all physicians, and allied research workers, who by their interest, capability, technical knowledge and practical experience demonstrated their eligibility. Election to membership acknowledges therefore the qualifications of a physician to practice radium therapy as a specialty or for the incidental case tradition has assigned to the particular field in which he or she specializes.

If this policy is changed, will it not disturb the relationship existing between those exceptionally well versed in technicalities and those exceptionally well versed in regional anatomy and pathology?

In answering this question, one must not be unmindful of the fact that dermatologists and surgical specialists, knowing the fundamental principle of radium therapy, may in the future as they have in the past, develop many uses for both radium and roentgen rays; furthermore, one must not be unmindful of the fact that the radiological field has grown to large proportions making it a life long task for an individual to cover unassisted the entire field.

The statement "to cover unassisted the entire field" brings up the question of whether it is necessary to combine radium and roentgen rays, and again speaking as a radium therapist, my answer would be based on the following technicalities:

Those using radium do not question the value and the need for roentgen rays in diagnosing and outlining deeply seated lesions. That they must intrust this technicality to others is not, by any means, a reflection on their willingness to cooperate in reading the gross pathology portrayed.

Beta radiation from radium has no counterpart in roentgen rays. It may be said that there is little use for beta rays; nevertheless, they extend the radiological field to a point beyond the reach of the roentgen ray.

For superficial lesions, radium and roentgen rays have many points in common. For profuse non-malignant lesions of the skin, roentgen rays are a decided advantage. For small lesions of this type, beta- and

* President's Address, delivered at the Twentieth Annual Meeting, American Radium Society, Atlantic City, N. J., June 10–11, 1935.

gamma-ray contact or modified distant applications of radium are equally effective, and for malignancies, somewhat more so. In these conditions, there is, then, very little interdependence.

Intensive roentgen radiation and large amounts of radium used at various distances also have many points in common. Provided intensities are equalized, many deeply seated lesions can be irradiated equally well with either, and either may, in some instances, be augmented by cavity applications of radium; so, in this work, radium has advantages.

Radium (or radon) may be placed *on* and *in* lesions. The radiation concentration cannot be duplicated by roentgen rays nor, for that matter, by distant applications of radium. It is true that many lesions do not require these rather drastic measures; nevertheless, they mark a limitation in roentgen therapy.

Combining radium and roentgen rays or substituting one for the other springs from a natural desire to increase the radiation dose over and above that possible with the radium or roentgen equipment at hand, and this, in turn, creates the need for a universal method to determine intensities. Is this possible? Perhaps, but not by using artifical rays as a standard.

This unceremonious assumption is based on certain mechanical and physical differences that exist between naturally and artificially produced rays, which are summarized:

First: Roentgen rays do not have the flexibility in application.

Second: Beta rays do not form part of the roentgen-ray beam.

Third: Roentgen rays do not always have stability in output.

Fourth: In contact and buried radiation, neither the character of the radiation nor the intensity of the dose is comparable one with the other, with roentgen rays or with distant applications of radium.

Fifth: Within reasonable bounds and with all other technicalities equalized, one may, by adjusting the time of application, duplicate the intensity delivered by different amounts of radium—meaning that it is a comparatively simple matter to adjust the radium dose.

Sixth: The penetrating power of roentgen rays can be placed on a par with the hard gamma rays emitted by radium C, but, for this equalization, the voltage must be well over 2,000,000—an item not to be taken lightly for more than one reason.

Seventh: In using these high intensities for deep irradiation, a dose based on the roentgen unit is safe only when accurately calculated and precautions taken to protect the intervening tissue from too much volume. That this act obscures the skin reaction is, so far as intensive distant doses of radium are concerned, quite apparent, which would indicate defects in calculation or differences in biological reactions.

Technically speaking, therefore, the mobility, utility, flexibility and greater stability of the radiation output makes radium, rather than roentgen rays, the major form of radiation and the logical agent to use in the formation of intensity or dose standards. Being able to cover practically the entire field, its adherents fail to see why they must also be well versed in roentgen-ray technicalities and roentgen-ray standards.

Now, if the facts are as stated, those using radium should create a better understanding of its therapeutic scope. With this thought in mind I have, on several occasions, suggested the need for a comprehensive classification of methods—a classification that will set forth indications and essential technical details.

This is, of course, the function of the Standardization Committee; therefore I may only suggest ideas in classification and certain changes in terminology, and this I do simply to make clear the necessity for revision.

In educational work, abbreviated identification labels and dose equations (packs, French method, milligram-hours, etc.) are discarded and methods listed and labeled according to the following physical and

mechanical characteristics which, in substance, means according to their intensities:

1. Type of application . . . { Contact—continuous or interrupted; Implant—permanent or limited; Distant—continuous or interrupted }

2. { Point source makeup . . { Container—material and thickness; Holding chamber dimensions; Tissue area covered; Amount of radium or radon } or { Type of rays . . . . . { Soft beta; Hard beta plus soft gamma; Soft gamma plus hard gamma; Hard gamma } }

3. Time of application . . . { Beta rays in minutes; Gamma rays in hours }

Identification labels based on technical factors will, of course, be unwieldy for oral discussions; nevertheless, if errors in duplication (an outstanding evil) are to be avoided, fundamental technicalities must be made clear.

To indicate the utility of a method is a different matter. Time does not permit me to discuss biological reactions or theories in respect to the susceptibility of cells and supporting tissues. But to bridge certain gaps, suppose a certain intensity creates a reaction terminating in pliable scar tissue.

If this intensity is greatly reduced and the lesion is entirely radiosensitive, the pathology, for some unknown reason, will clear up and there is only clinical evidence on which to base an opinion of the modus operandi.

If the lesion is semi-radiosensitive, the pathology will be checked but not controlled—again nothing but clinical evidence.

If the lesion is of the resisting type, it is not clinically or microscopically affected.

Suppose, on the other hand, the intensity is stepped up. Here, depending on the increase, the result will either be contracted scar tissue or complete necrosis.

Considered in this light, we have four major irradiation possibilities. To indicate these possibilities, distinctive identification labels are necessary, but because definite knowledge of the biological reaction is sometimes lacking and because it is not always possible, as in roentgen-ray applications, to use terms indicating skin reactions, we must, in some instances, indicate the clinical possibility.

Having classified methods in respect to their physical and mechanical makeup and established as best we may their irradiation possibility, it remains to indicate their therapeutic utility. So far as neoplastic diseases are concerned, this would be of no great value unless the comparative resisting power of normal and the susceptibility of abnormal tissues were matters of common understanding.

If we rate the resistance of normal tissues as we rate the screening properties of certain inert substances—by their density—we may obtain a fairly accurate idea in respect to the resisting power of various types, and at the same time, eliminate tumor formations wherein strongly resisting tissues predominate.

By compiling clinical, experimental and microscopical evidence, several clinicians with large experience have listed neoplastic diseases according to their irradiation response. These lists show a remarkable similarity; consequently, what I have proposed is entirely within reason.

No matter how accurately intensities are classified or how this or that intensity seems to accommodate a particular pathologic group, all physicians should understand that a fixed radiation dose must, on occasions, be altered to meet conditions found in the individual case; therefore each case should be subjected to a routine clinical investigation embracing:

The Lesion: History, stage, location, size, shape, consistency, fixation, induration, intratumoral circulation, possible metastasis, and if possible, histological grading.

The Surrounding Tissue: Blood supply, lymphatic drainage and resistance.

The Patient: Age, sex, general condition.

With an experience of over twenty years, during which time I have tried almost all proposed methods and used amounts of radium ranging from 50 micrograms to

2,000 milligrams, I feel justified in giving voice to the following clinical observations:

For non-malignant conditions placed in the so-called suberythematous class, one may use any *contact* or *distant* method provided the dose is delivered homogeneously; provided glandular function is not greatly disturbed, and provided skin surfaces are not marred. For susceptible neoplasms in the autolytic class, the size and location may dictate a choice between a contact and distant dose.

That this observation is substantially correct, is, I believe, demonstrated by the number of different methods that apparently give about the same curative percentages.

Knowing limitations is a matter of experience. For instance, when a case is clearly one for palliation, I have found it inexpedient to subject the patient to intensive contact or buried doses when it is possible to obtain a full measure of relief by well delivered distant doses.

For semi-susceptible cases—cases for irradiation and surgery—a *buried*, *contact* or *distant* dose should be directed toward suspension of cell activity; blocking draining lymphatics; reducing the size of the tumor, and curbing surrounding and intratumoral circulation—this three to four weeks before and not after removal.

In cases presenting nearby or distant extension, expectant irradiation with the *distant* method is wise. I have seen much palliation and no radiation complications with distant radium applications.

For carcinomas: To know the factors that exclude entirety or indicate the degree of causticity needed and to have at hand the necessary equipment for adequate contact, buried and distant irradiation, is to increase one's curative and palliative percentages above the average.

In conclusion: I have attempted to demonstrate the fact that, so far as naturally produced rays are concerned, it is possible to cover practically the entire radiotherapeutic field. That those who use roentgen rays sometimes find it necessary to combine artificially and naturally produced rays is a point that I may discuss from a theoretical standpoint only. In the matter of qualifications, I do not feel that I have the professional right to invade the non-malignant dermatological field, for instance, nor do I believe that any technical knowledge I may have transcends extraordinary knowledge of regional anatomy and pathology.

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Twenty-first Annual Meeting: Kansas City, Mo., May 11–12, 1936.

EDITORIALS

ROENTGEN THERAPY BY THE METHOD OF CHAOUL

DURING recent years, particularly in Germany, an increasing interest is being shown in roentgen irradiation by what is known as the method of Chaoul. In this country the development of roentgen-ray equipment has been centered either upon deep or supervoltage therapy. In Germany, where radium is scarce and very expensive, it was necessary to find some substitute from which it would be possible to approximate the same conditions as those obtained in radium therapy.

Our interest in therapy by the Chaoul method has been stimulated through the generosity of Mr. W. H. Donner, President of The International Cancer Research Foundation. He has provided a complete Chaoul unit for the University of Pennsylvania Hospital and funds which enabled me to go to Europe to study the methods of the treatment employed.

Since there is no American literature on this subject, it has seemed justifiable to detail the results as I saw them and to review somewhat the available literature for those radiologists who may be interested.

Therapy by the Chaoul method is essentially limited to the realm of relatively low voltage, 50 to 60 kv., and *short focal target skin distances* of 3 to 5 cm. This has been made possible through the change in design of the roentgen tube and generator and making the equipment shock proof. Utilizing such factors it is obvious, therefore, that this therapy was developed to treat the superficial lesions in which radium has been the usual therapeutic agent in this country. Schaefer and Witte[1] have employed similar roentgen tubes (100 kv. capacity at 4 ma.) in the treatment of uterine carcinoma that has involved the parametrium, inserting the active end of the tube into the vagina.

Chaoul and Adam[3] outline their reasons upon which this new therapy is based. These are abstracted as follows:

Experiments tend to show that the biological effect does not depend upon the wave length. Great stress is placed upon the work of Holthusen. He compared roentgen radiation 0.37 mm. Al half-value layer (30 kv. without filter) with gamma rays of radium and found that after equal doses had been applied there was no demonstrable quantitative or qualitative difference in the skin erythema and the effects on *Ascaris* eggs. Englmann showed that the morphological changes of tumor cells treated with roentgen rays and radium showed qualitatively and quantitatively a striking similarity, if the quantities measured in roentgens were the same in all cases. Franke (quoted by Chaoul and Adam) explains the independence of the biological reaction of wave length as follows:

"That in accordance with the first basic law of photochemical reaction, it is conditional that with any such photochemical reaction (as what one may regard the effect of a radiation on the biological tissue) the radiation is absorbed by the tissue (Grothues and Draper). As a result thereof, selective actions can take place only if they are the sequence to a selected absorption. While with the absorption of light, as the example of organic dye stuff shows, new absorption effects can be brought about by apparently small changes in the grouping of particles of the same kind, changes in the grouping of particles have no influence on the absorption of roentgen radiation (Walter, *Fortschr. Roentgenstr.*, Bd. 1). Accordingly for such substances which consist of the same kinds of atoms a change of reaction by changes of the wave length cannot be expected."

Chaoul therefore feels from the experiments mentioned above and many others, that the quality of radiation is becoming insignificant and that the physical and technical conditions of irradiation are assuming importance.

In order that the method of dosage may be understood, Chaoul has reviewed the work of Krönig and Friedrich published in 1917, and the experiments of Regaud. Their observations suggest that daily applications of small quanti-

ties of radiation tend to increase the tolerance of the skin and it was upon this premise that Coutard has based his treatment. Whether the success of the Coutard method is due to fractionating or due to protraction of the dose is still problematical. Chaoul contends that the increase in skin tolerance is due to the sequence of intervals between the individual treatments and the aggregate duration of the total treatment. The r/min. input becomes effective only when a time of four to five hours per individual treatment is exceeded. He also states that it is irrelevant whether a given quantity of radiation is applied within this total of time by a continuous treatment, i.e. protracted treatment with a small r/min. input or by a random number of individual treatments, i.e. fractionated with an accordingly higher intensity. Chaoul admits, however, that it may be possible that further improvements will lie in the direction of protraction.

Chaoul, in discussing the superior results obtained by radium over the conventional roentgen technique as applied in Europe, does not feel that the superior results of radium were due to a *selective action*, but rather to the fact that the radium skin distance was short and the majority of the energy was absorbed in the tumor area, thereby sparing the tumor bed, and finally the area treated was small thus allowing a large dosage.

Of course, when teleradium therapy is used, the distribution of absorption in the tissues simulates that of high voltage roentgen therapy when the focal skin distance is the same.

It was these ideas that prompted the attempt to adapt technical conditions of roentgen irradiation to those of radium contact therapy. Two ways were possible:

1. The utilization of the losses of absorption by the application of a soft or unfiltered radiation.

2. The utilization of the decrease by the square of the radiation intensity by reducing the distance between tumor and source of radiation.

The latter was the more practical and lent itself to the treatment of a greater variety of lesions.

Chaoul states early in his experience that the roentgen contact therapy should prove equal to the radium contact methods and stresses the point that one obtains a more homogeneous radiation from the roentgen tube than is possible from multiple point sources in contact radium therapy.

The premises upon which roentgen contact therapy is based can therefore be summarized as follows:

1. There is no difference between the clinical effects of the same dose of roentgen radiations of different wave lengths, the important factors being the energy absorbed per cubic centimeter and the time spacing of the irradiations.

2. The healthy surrounding tissues should be spared irradiation as much as possible in order to aid subsequent repair.

3. The distribution of radiation in the tissues with small focal skin distances is similar to that obtained with radium surface applicators and "bombs."

4. The high dosage rates of the roentgen apparatus make it possible to treat many patients.

5. The expense is not so great as with radium.

Physical Characteristics of the Tube and Generator. According to Mayneord (measurement of low voltage roentgen rays, article unpublished as yet) the source of high tension employed is a simple constant potential generator (Siemens' "Monopan") using a Greinacher circuit and having a maximum output of 60 kv. and 4 ma. The tube has been described by Ernst, Frik and Ott.[11] It is so designed as to have the source of radiation at one end of an earthed metal tube, the rays emerging through the target of gold plated nickel and the water cooling jacket. These factors constitute the filters usually employed and, according to Morison, Hugo and Mayneord,[14] is equivalent to approximately 0.2 mm. nickel. The mean wave length is roughly 0.32 Å (see Figs. 1 and 2).

Mayneord has developed a very small ionization chamber, a description of which

will be published shortly, along with a series of physical measurements of spectra, half-value layers, back-scattering, percentage depth doses, etc. His observations compared favorably with those of Ernst, Frik and Ott.

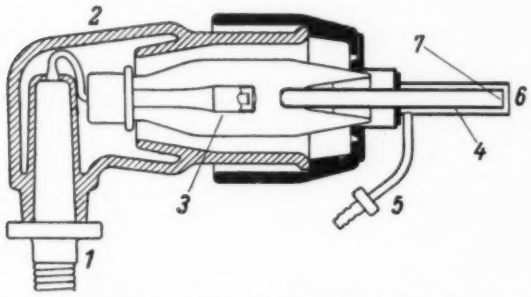

Fig. 1. Drawing of the tube taken from the article by Ernst, Frik and Ott.[11] 1. High tension current. 2. Porcelain shield to the tube. 3. Cathode. 4. Anode. 5. Water cooling lead. 6. Aperture for rays. 7. Focal spot.

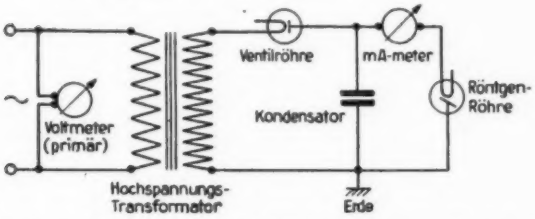

Fig. 2. Drawing of the Greinacher circuit, taken from the article by Ernst, Frik and Ott.[11]

The portal of entry is limited by the metal applicators which are adjusted over the end of the tube. The target skin distance most frequently used is either 3 or 5 cm. The shape of the end of the applicator may be oblong, square, circular or any shape, depending upon the lesion being treated.

The depth doses are similar to those of radium. Morison, Hugo and Mayneord report the following, and they are in agreement with those reported by Chaoul.

Table I

5 cm. focal skin distance and 4 cm. diameter circular field.

Depth in cm.	Percentage of surface doses
1	68
2	44
3	29
4	19

The isodose curves show considerable falling off of radiation going outward from the central beam. This allows overlapping of fields with safety.

The dosage rate in air at 5 cm. focal skin distance, 60 kv. and 4 ma. in approximately 110 r/min., while with back-scattering, this normally increases to about 130 r/min. This dosage rate is approximately 25 times that obtained from a 1 gram radium "bomb," at the same focal skin distance. In the early days of this new work Chaoul used a low intensity and a long period of application (1½ hours) but he soon gave this up for the routine described above. It is most interesting to find that Chaoul in his most recent paper[13] has described the use of short distance (contact) therapy utilizing higher voltages in order that dosage distribution similar to that delivered by 6 cm. distance radium bombs might be approximated.

Clinical Observations. Chaoul has published several papers and Morison one recently in which they state that the daily dose per field is 400 r, the output per minute being 100 to 150 r. The short time of application renders the method ideal in treating certain lesions in the mouth and pharynx where it would be impossible to treat for a long period. Several fields may be treated at one sitting. The total dose delivered to a given portal depends to a large extent upon the reaction of the lesion to the treatment. Ordinarily on the fourth day, a mild erythema may be present. This is followed in a few days by pigmentation. The erythema and the pigmentation depend largely on the usual factors: region of body treated, condition of the skin, vascularity of the tissues, etc. The edge of the erythematous area is very sharply marked, corresponding to the rim of the applicator. Although there is a 40 per cent difference between the dosage of the edge of the field and that at the center, the skin reaction appears to be relatively uniform.

The total dosage to a given portal varies considerably, from 4,000 to 20,000 r. It is usually 5,000 to 6,000 r per field, spread

over a period of about fifteen days. The size of the field averages 10 to 15 sq. cm. and never exceeds 20 sq. cm. After intense irradiation skin sloughing results, but epithelization rapidly proceeds from the periphery to cover the area, resulting in a pale scar. An intense purple erythema, appearing during treatment and accompanied by a slough, is a warning to interrupt treatment. After the reaction subsides (three to four weeks), if the tumor has not disappeared, treatment may be started again. High doses are unnecessary if the tumor begins to disappear during treatment. The reactions of the skin and mucous membrane are similar to those observed in irradiation by Coutard's method.

Chaoul[13] stresses the importance of not giving his type of therapy over areas having received the conventional doses of roentgen rays or radium, because of the danger of developing delayed radiation effects. Up to the present ($3\frac{1}{2}$ years) he has not observed any serious delayed effects in any of his patients. Morison, on the other hand, feels that if several months have elapsed, it is safe to irradiate by Chaoul's method over the same portal.

In the larger and deeper lesions Chaoul has recently begun to use roentgen therapy consisting of the following factors: 180 kv., focal skin distance 10 cm., filter 0.5 mm. Cu, field 28 sq. cm., dosage 150 to 200 r daily, usual total dose 3,000 r. He advises one not to exceed the total dose of 5,000 r.

Indications for Roentgen Therapy by Chaoul's Method. Chaoul recommends contact therapy in the following types of conditions:

Skin Cancer:

Buccal cancer including lesions involving the lips, cheek, tongue, alveolus, tonsil and pharynx. Occasionally it may be necessary to use local anesthesia to remove the gag reflex or lessen the pain in order to treat the lesion.

Mammary Cancer. The recurrent nodules.

Cancer of the Cervix. Schaefer and Witte have treated several hundred cases and Martius is convinced that this type of therapy is an addition to our armamentarium, when there is extension into the parametrium. The tube of Schaefer and Witte uses slightly higher voltages (100 kv.), and the tube is introduced into the vagina and directed on the lesion. The value of this therapy over radium applied to the same field is the better depth dose obtained from the roentgen rays.

Deep-Seated Lesions. Chaoul states that these lesions present a notable opportunity for cooperation between the surgeon and radiologist. Thus in a patient with cancer of the rectum, the surgeon performs a preliminary colostomy, then resects the coccyx and the lower portion of the sacrum exposing the cancer. The wound is packed and kept open for subsequent contact therapy. Chaoul and Morison believe that with further experience in this type of therapy, with development of tubes designed for certain lesions and areas, and with closer cooperation of the surgeon, distinct advances in cancer therapy may be possible.

It seems scarcely fair for one who has had an experience of only two weeks' observation in the clinic of Professor Chaoul at the Charité in Berlin and of Professor Morison in the Free Cancer Hospital in London to offer any conclusions. It should be stated, however, that these two radiologists are tremendously enthusiastic, and a number of machines are in use in Germany and at least two in England. Chaoul and Morison have had a long and extensive experience with other forms of roentgen therapy and Morison has had experience with radium. It therefore behooves us to evaluate their results carefully and compare them with those obtained in this country from radium, roentgen therapy and electrocoagulation.

For those who may wish to read the original articles on this subject, a complete bibliography follows.

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Eugene P. Pendergrass

RALPH VINCENT ROBINSON
1884-1935

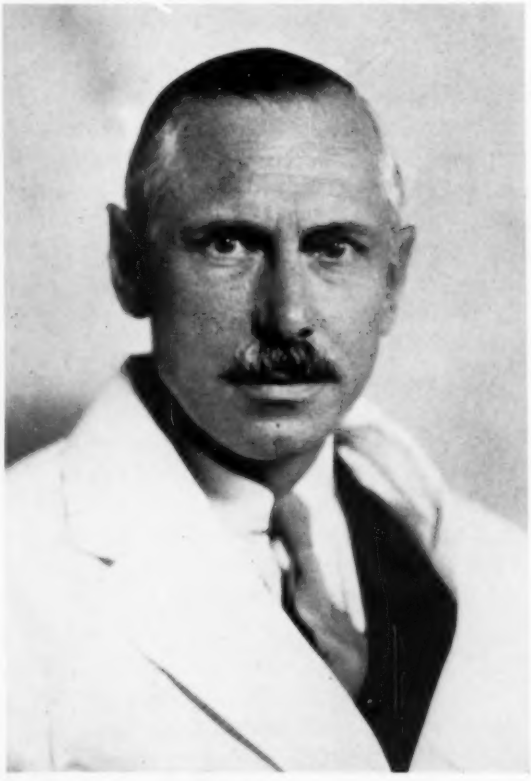
Photograph by Bachrach

RALPH VINCENT ROBINSON was born September 26, 1884, and died suddenly of coronary thrombosis on October 5, 1935. He attended California State Normal School in California, Pa., and was graduated in medicine from the University of Pittsburgh in 1911. He served his internship at St. John's General Hospital, following which he served as resident physician at the Children's Hospital in Pittsburgh for one year. He then entered the general practice of medicine in the office of the late Dr. George McNeil, where he remained for two years. At this time he became associated with Drs. Johnston and Grier in the practice of roentgenology, which specialty he followed, until his death. He was at various times on the staff of the Mercy, the Presbyterian and the Children's Hospitals.

During the World War he was a captain in the Medical Corps, serving as roentgenologist in the hospital at Camp Pike. He was a diplomate of the American Board of Radiology, and a member of the American Roentgen Ray Society and the American Medical Association. He was also a member of the Board of Directors of the Allegheny County Medical Society.

He is survived by his widow and one son, Ralph Vincent Robinson, Jr.

HEINZ LANGER
1888-1935



HEINZ LANGER, internationally known for his work in the field of roentgen therapy, died of pneumonia at the Western Pennsylvania Hospital, Pittsburgh, Pa., on September 28, 1935.

Dr. Langer was born in Hanover, Ger-

many, June 20, 1888. Educated at Jena University, he also recived his doctor's degree there, studying under the world renowned Heckel, and helping to arrange the Heckel Museum of Comparative Zoology and Evolution. He was then associated with Erlangen University as Director of the Gynecological Department.

Specializing in roentgenology, he studied under Professor Roentgen, and worked with two other world famous leaders in this field, Wintz and Seitz.

During the World War, Dr. Langer was a medical officer with a Bavarian Regiment. He saw service during the entire four years of the war and was awarded the Iron Cross. After his arrival in this country, he was invited on numerous occasions to speak before American Legion groups and was elected an honorary member of that organization.

Coming to the United States in 1923, Dr. Langer continued his work in radiotherapy and two years later became attached to the Western Pennsylvania Hospital Staff as head of the Physiotherapy and X-ray Department.

Dr. Langer was a member of the American Roentgen Ray Society, the American Medical Association and the American Medical Editors and Authors Association. He is survived by his widow, Margherita Chiari Langer, his parents, Adolph and Margarite Parisius Langer, and two brothers.

HARRY BERNARD PODLASKY
1883-1935

HARRY BERNARD PODLASKY, aged fifty-two, died on Sunday afternoon, November 2, 1935, of coronary disease after an illness lasting less than an hour. There had apparently been no forewarning since he had spent most of the morning at Mount Sinai Hospital writing reports on hospital cases which had not been finished during the immediately preceding week days.

He was a graduate of Jefferson Medical College of the class of 1909 and had done general practice in Milwaukee for some years before the war. He received training in roentgenology under Dr. L. G. Cole during the World War and returned to

H. W. Brown

Milwaukee to commence special practice in 1920. In 1923 he became a member of the American Roentgen Ray Society and at the time of his death held membership in the American College of Radiology, the American College of Physicians, the Radiological Society of North America, the Milwaukee Academy of Medicine, the Milwaukee County Medical and the Wisconsin State Medical Society, and the American Medical Association. He had served for a number of years as head of the department of roentgenology at Marquette Medical School, and of the x-ray department of Mount Sinai Hospital while at the same time engaging in private roentgenological practice.

As one of the charter members of the

oldest state section of roentgenology, that of the Wisconsin State Medical Society, founded at Green Bay in 1924, and of the Milwaukee Roentgen Ray Society, he was continuously active in the scientific work of these bodies, having been past chairman of the state section and at the time of his death president of the Milwaukee Society. He was a constant and aggressive fighter for the economic rights of hospital radiologists and was in the midst of a State program to follow up the results accomplished at the recent Wisconsin State Medical Society meeting held in September, 1935, at Milwaukee when the House of Delegates of that body adopted resolutions similar to those adopted by the American Medical Association at the Atlantic City meeting last June referring to hospital radiologic practice.

His passing is mourned by a large circle of medical and non-professional friends to whom he was affectionately known as "Pod." He is survived by his wife Rose and a daughter Judith.

J. E. HABBE

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Cleveland, Ohio, Sept. 29–Oct. 2, 1936.

American College of Radiology
Secretary, Dr. B. H. Orndoff, 2561 N. Clark Street, Chicago, Ill. Annual meeting: Kansas City, Mo., 1936.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Kansas City, Mo., May 11–15, 1936.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting, 1936: To be announced.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut State Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets annually in May. Special meetings may be called by the Chairman.

Radiological Section, Los Angeles County Medical Society
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas. Annual meeting, Baltimore, Md., Nov. 17–20, 1936.

Brooklyn Roentgen Ray Society
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, General Hospital Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, North W. Shetter, M.D., 14600 Detroit Ave. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Denver Radiological Club
Secretary, Dr. K. D. A. Allen, 452 Metropolitan Building, Denver, Colorado. Meets on any month having a fifth Monday.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida State Radiological Society
Secretary, Dr. Gerard Raap, Miami, Florida. Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill. Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind. Meeting held the second Sunday in May annually.

Long Island Radiological Society
Secretary, Dr. M. Dannenberg, 1464 Eastern Parkway, Brooklyn, N. Y. Meets on third Thursday of each month from October to May, at 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting designed by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn. Meets in St. Paul, Minn., in March, 1936.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

New York Roentgen Society
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N. Y. Three meetings a year—January, May, and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Next annual meeting June 5 and 6, 1936, Lycoming Hotel, Williamsport, Pa.

Philadelphia Roentgen Ray Society
Secretary, Dr. Thomas Loughery, Germantown Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital. Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Ray Society
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston Meets at time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Virgil Ionescu, B-dul Schitu Măgureanu 49, Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

NOBEL PRIZE AWARDS IN PHYSICS AND CHEMISTRY

The Nobel Prize in physics for 1935 has been awarded to Dr. James Chadwick, of the University of Liverpool, for his discovery in 1932 of the neutron, made while working in the Cavendish Laboratory of the University of Cambridge. The Nobel Prize in chemistry for 1935 has been awarded to Professor Frederick Joliot and Mme. Irene Curie-Joliot for their synthesis of radioactive elements, working in the Curie Laboratory, Paris. The award to Irene Curie-Joliot is the first instance of the child of a Nobel Prize winner receiving the Nobel Prize for, as all radiologists know, she is the daughter of the late Pierre Curie and Marie Curie, who jointly with Henri Becquerel received the Nobel Prize in physics in 1903 for their work on radioactivity. Marie Curie also received the Nobel Prize in chemistry in 1911 for the isolation of radium, thus becoming for the second time a Nobel Prize winner, a unique achievement.

Science Service

FREDERICK JOLIOT IRENE CURIE-JOLIOT JAMES CHADWICK

In its announcement of the awarding of the Nobel Prizes for 1935, the *New York Times* (November 15, 1935) goes on to explain the work of Dr. Chadwick as follows:

The neutron is a fundamental particle, one of the building blocks of the universe. Unlike other elementary particles of nature, such as electrons, protons and positrons, which carry unit charges of negative or positive electricity, the neutron, as its name implies, carries no charge whatsoever. In this respect it is unique in nature.

Because it carries no electric charge the neutron is not subject to the influences of the electric fields guarding the nuclei of atoms. The neutron is therefore the most powerfu projectile obtainable for smashing the citade guarding the atomic nuclei with all its tremendous locked-up energy.

Until the neutron's discovery by Dr. Chadwick in the famous Cavendish Laboratory it was universally believed that nature was made up of only two types of fundamental particles: the electron, a unit of matter carrying a negative unit of electric charge, and the proton, a unit carrying a positive unit of electric charge. All the ninety-two elements of which nature is composed were believed to be made up of electrons and protons in various combinations.

The discovery of the neutron thus not only furnished to science a new fundamental building block and the most powerfully penetrating atom-bullet, but it also brought about a radical revision of the picture of the architecture of the universe. The elements were found to be composed of at least three fundamental particles. The discovery of the positron that same year

by Dr. Carl D. Anderson of the California Institute of Technology changed the picture to four.

The nature of the neutron itself is still far from being determined. There still exists the possibility that it is composed of an electron and a proton held closely together.

The work of the Joliots is of special interest to radiologists since production of artificial radioactivity promises to have both a medical and industrial importance. The *New York Times* (November 15, 1935), in reference to their work, reports as follows:

Radium and the other radioactive elements were freaks of nature, however, very rare and therefore very costly. The daughter of the discoverers of radium and her husband, working in the same laboratories in which Marie Curie had carried on her work until her death, discovered a method for taking ordinary abundant elements, such as table salt, and converting them into substances that emanate rays of the same type as those emitted by radium.

Research along the lines opened up by the Joliots is going forward actively at a number of places and further interesting discoveries may be expected.

SECOND CONGRESS OF THE PAN-PACIFIC SURGICAL ASSOCIATION

The Second Congress of the Pan-Pacific Surgical Association will be held in Honolulu, Hawaii, August 6 to 14, 1936. Extensive plans are being made for this meeting which will again unite the surgeons from all the countries around the Pacific Ocean. The First Congress was held in Honolulu in August, 1929. This was an outstanding success, with attendance from Australia, New Zealand, New South Wales, the South Sea Islands, China, Japan, Canada and the United States. At this 1929 meeting an organized Surgical Association was formed by the delegates present and Dr. George W. Swift of Seattle, Washington, was elected President. Since there was only one paper on this program dealing with radiology, it was suggested that a special Section on Radiology be added to the Surgical Congress. This was done and Dr. Carl J. Johannesson of Walla Walla, Washington, was appointed Chairman of this Section; he has also been appointed as the official representative to attend and represent the American Roentgen Ray Society at the coming Congress in 1936.

D. Johannesson wishes to extend an invitation to radiologists in countries around the Pacific Ocean to unite with those from the United States and Canada in providing an instructive and valuable program on radiology with special reference to surgical radiology under the following headings: (1) gastrointestinal and abdominal diseases; (2) neoplastic diseases; (3) radiation therapy.

Dr. Johannesson invites the members of the American Roentgen Ray Society to attend the Second Pan-Pacific Surgical Congress, and those who wish to present papers or to show roentgen films or clinical photographs with case histories selected for their pathological significance should communicate with Dr. Johannesson as soon as possible as Dr. Swift is anxious to have the tentative program in shape by February or March.

The Section of Radiology of the Australasian Medical Congress, the New Zealand British Medical Association, the Radiological Society of Japan, and others, are anxious to make the Section on Radiology a success, and have signified their intention of sending official representatives.

In accordance with the rules and regulations of the Pan-Pacific Surgical Association, membership in the Congress is open to (a) members of the national roentgen societies regularly constituted, and (b) persons accepted by the Association.

It is urged that those radiologists who wish to participate in this Congress communicate with Dr. Carl J. Johannesson, 205 Baker Building, Walla Walla, Washington, as soon as possible.

MINNESOTA RADIOLOGICAL SOCIETY

The Minnesota Radiological Society held its winter meeting at the Nicollet Hotel in Minneapolis on Saturday, December 14, 1935. The following program was presented:

Radiation Therapy of Carcinoma of the Lip—A. L. Abraham and W. K. Stenstrom, Minneapolis.

Roentgen Study of the Results of Epiphyseal Injuries—Oscar Lipschultz, Minneapolis.

The Dangers of Reducing Fractures Under the Fluoroscope—E. T. Leddy and C. A. Stevenson, Rochester.

Demonstration of Some Bone Changes in Children—M. J. Shapiro, Minneapolis.

Roentgen Study of Spontaneous Internal Biliary Fistula—C. N. Borman, Minneapolis.

Experiences with Roentgen Therapy of More Than 3,000 r in One Month—W. K. Stenstrom and Lewis Jacobs, Minneapolis.

Combined Heat and Roentgen Therapy of Tumors: Review of the work of Stafford Warren and Associates.—C. O. Hansen, Minot, N. D.

The next meeting of the Society will be held in St. Paul in March.

DR. FRED M. HODGES HONORED

At the recent meeting of the Southern Medical Association in St. Louis, Dr. Fred M. Hodges of Richmond, Virginia, was elected President. Dr. Hodges, President of the American Roentgen Ray Society and outstanding both in his professional and personal relationships, is worthy of this honor, and radiologists will feel gratified to learn of his election to the high office of such an important and well-known Association. Both the Southern Medical Association and Dr. Hodges are to be congratulated.

THE AMERICAN COLLEGE OF PHYSICIANS

The Twentieth Annual Session of the American College of Physicians will be held in Detroit with headquarters at the the Book-Cadillac Hotel, March 2–6, 1936.

Dr. James Alex. Miller, of New York City, is President of the College, and has arranged a program of general scientific sessions of great interest to those engaged in the practice of Internal Medicine and associated specialties. Dr. Charles G. Jennings, of Detroit, is the General Chairman of the Session, and is in charge of the program of clinics and demonstrations in the hospitals, medical schools and other Detroit institutions. Dr. James D. Bruce, Vice President in Charge of University Relations, University of Michigan, is Vice Chairman of the Committee on Arrangements, and has in charge the preparation of an all-day program to be conducted at the University of Michigan on Wednesday, March 4. Dr. Walter B. Cannon, Professor of Physiology at Harvard University Medical School, will deliver the annual Convocation Oration on "The Rôle of Emotion in Disease." Dr. Miller's presidential address will be on "The Changing Order in Medicine." About fifty eminent authorities will present papers at the general scientific sessions, while clinics and demonstrations will be conducted at the Harper, Receiving, Ford, Grace, Herman Kiefer and Children's Hospitals, of Detroit.

DAVID ANDERSON-BERRY PRIZE

The Council of the Royal Society of Edinburgh have made the first award of the David Anderson-Berry Prize to Charles Melville Scott, M.A., M.B., D.Sc., Lecturer in Materia-Medica in the University of Edinburgh, for his essay "On the Action of X and Gamma Rays on Living Cells."

This Prize which consists of a gold medal and a sum of money, was founded by the late Dr. David Anderson-Berry in 1930, and is awarded triennially to the person who, in the opinion of the Council, has recently produced the best work on the nature of roentgen rays in their therapeutic effect on human diseases.

DIPLOMATES OF THE AMERICAN BOARD OF RADIOLOGY

The following is a complete list of the radiologists who have appeared before the American Board of Radiology and passed a satisfactory examination in the field indicated:

1. ALEXANDER, FAY K., Philadelphia, Pa., *Radiology.*
2. ALLEN, B. M., Wilmington, Del., *Diagnostic Roentgenology.*
*3. ALLEN, BUNDY, Tampa, Fla., *Radiology.*
4. ALLEN, KENNETH D. A., Denver, Colo., *Radiology.*
5. ALLEN, LEWIS G., Kansas City, Kan., *Radiology.*
6. ALLEN, M. Lowry, Philadelphia, Pa., *Radiology.*
7. ALLEN, William E., Jr., St. Louis, Mo., *Roentgenology.*
8. ALLEN, REUBEN G., Pittsburgh, Pa., *Diagnostic Roentgenology.*
9. ALLISON, R. G., Minneapolis, Minn., *Roentgenology.*
10. ALTMAN, WILLIAM S., Quincy, Mass., *Radiology.*
11. ANÉ, JOSEPH N., New Orleans, La., *Radiology.*
12. ANSPACH, WILLIAM E., Chicago, Ill., *Roentgenology.*
13. ARCHER, VINCENT W., University, Va., *Roentgenology.*
14. ARENS, ROBERT A., Chicago, Ill., *Radiology.*
15. ASHBURY, HOWARD E., Baltimore, Md., *Roentgenology.*
16. ATKINS, SAMUEL M., Waterbury, Conn., *Roentgenology.*
17. AURELIUS, J. RICHARDS, JR., St. Paul, Minn., *Roentgenology.*
18. AVERY, PHILIP S., New Brunswick, N.J., *Roentgenology.*
19. BACHMAN, M. H., Youngstown, Ohio, *Roentgenology.*
20. BADER, ELLIS R., Cincinnati, Ohio, *Radiology.*
21. BAILEY, WILBUR, Pasadena, Calif., *Radiology.*
22. BAKER, CHARLES F., Newark, N.J., *Roentgenology.*
23. BAKER, EDGAR C., Youngstown, Ohio, *Radiology.*
24. BALL, ROBERT P., Chattanooga, Tenn., *Diagnostic Roentgenology.*
25. BARFIELD-CARTER, M., Birmingham, Ala., *Roentgenology.*
26. BARKER, W. ALLEN, Petersburg, Va., *Roentgenology.*
27. BARNES, JOHN M., Buffalo, N.Y., *Roentgenology.*
28. BARNETT, ARTHUR F., Eugene, Ore., *Radiology.*
29. BARROW, S. C., Shreveport, La., *Radiology.*
30. BARTH, EARL E., Chicago, Ill., *Roentgenology.*
31. BAUER, AUGUST A., Chicago, Ill., *Roentgenology.*
32. BAUM, SAMUEL M., New York, N.Y., *Therapeutic Radiology.*
33. BAXTER, O. D., Sumter, S. C., *Radiology.*
34. BEELER, RAYMOND C., Indianapolis, Ind., *Radiology.*
35. BEILIN, DAVID S., Chicago, Ill., *Radiology.*
36. BELL, JOSEPH C., Louisville, Ky., *Roentgenology.*
*37. BENISHEK, WERNER L., Aurora, Ill., *Roentgenology.*
38. BENJAMIN, EMANUEL W., Providence, R.I., *Radiology.*
39. BERG, H. MILTON, Bismarck, N.D., *Radiology.*
40. BERNSTEIN, JOSHUA H., New York, N.Y., *Radiology.*
41. BETHEA, WILLIAM R., Memphis, Tenn., *Roentgenology.*
42. BIRKELO, CARL C., Detroit, Mich., *Roentgenology.*
43. BISHOP, PAUL A., Philadelphia, Pa., *Radiology.*
44. BLACKETT, CHARLES W., Boston, Mass., *Roentgenology.*
45. BLAINE, EDWARD S., Los Angeles, Calif., *Roentgenology.*
46. BLISS, GERALD D., Altoona, Pa., *Radiology.*
47. BOGAN, ISABEL K., Boston, Mass., *Roentgenology.*
48. BOGAN, MARY E., Brookline, Mass., *Roentgenology.*
49. BOGART, FRANKLIN B., Chattanooga, Tenn., *Roentgenology.*
50. BONNAR, JAMES M., New Bedford, Mass., *Radiology.*
51. BONOFF, KARL M., Los Angeles, Calif., *Diagnostic Roentgenology.*
52. BORZELL, FRANCIS F., Philadelphia, Pa., *Radiology.*
53. BOWEN, CARL B., Oakland, Calif., *Roentgenology.*
54. BOWEN, DAVID R., Philadelphia, Pa., *Radiology.*
55. BOWING, HARRY H., Rochester, Minn., *Therapeutic Radiology.*
56. BOYD, JAMES F., Providence, R.I., *Radiology.*
57. BOYES, JAMES G., Plainfield, N.J., *Roentgenology.*
58. BRADLEY, ROBERT A., Atlantic City, N.J., *Radiology.*
59. BRAMS, JULIUS, Chicago, Ill., *Radiology.*
60. BRENNEMAN, RICHARD E., Meadville, Pa., *Radiology.*
61. BRIDENBAUGH, J. H., Billings, Mont., *Radiology.*
62. BROESER, HENRY V., Hoboken, N.J., *Diagnostic Roentgenology.*
63. BROMER, RALPH S., Bryn Mawr, Pa., *Radiology.*
64. BROOKSHER, W. R., Fort Smith, Ark., *Radiology.*
65. BROUSE, IVAN E., Jacksonville, Ill., *Roentgenology.*
66. BROWN, H. O., Tampa, Fla., *Roentgenology.*
67. BROWN, PERCY, Boston, Mass., *Roentgenology.*
68. BROWN, SAMUEL, Cincinnati, Ohio, *Roentgenology.*
69. BRUCK, SAMUEL, Philadelphia, Pa., *Radiology.*
70. BRYAN, LLOYD, San Francisco, Calif., *Roentgenology.*
71. BURCHAM, THOMAS A., Des Moines, Iowa, *Radiology.*
72. BURNETT, HARRY W., Dayton, Ohio, *Roentgenology.*
73. BUTLER, PATRICK F., Boston, Mass., *Radiology.*
74. CALDWELL, CHARLES S., Pittsburgh, Pa., *Roentgenology.*
75. CAMP, JOHN D., Rochester, Minn., *Roentgenology.*
76. CAPP, CHARLES S., San Antonio, Tex., *Radiology.*
77. CARLSON, GLENN D., Dallas, Tex., *Roentgenology.*
78. CARR, EDSON W., Chicago, Ill., *Diagnostic Roentgenology.*
79. CARTER, RAY A., Los Angeles, Calif., *Roentgenology.*
80. CARTY, JOHN R., New York, N.Y., *Radiology.*
81. CASE, JAMES T., Chicago, Ill., *Radiology.*
82. CATHCART, JOHN W., El Paso, Tex., *Radiology.*
83. CHALLENGER, CHESTER J., Chicago, Ill., *Roentgenology.*
84. CHAMBERLAIN, W. EDWARD, Philadelphia, Pa., *Radiology.*
85. CHAPMAN, JOHN F., Pasadena, Calif., *Diagnostic Roentgenology.*
86. CHILDE, ARTHUR E., Montreal, Que., *Diagnostic Roentgenology.*
87. CHILDS, DONALD S., Syracuse, N.Y., *Roentgenology.*
88. CHRISTIE, ARTHUR C., Washington, D.C., *Radiology.*
89. CILLEY, EARL I. L., Bellingham, Wash., *Radiology.*
90. CLAIBORNE, ELMER M., New York, N.Y., *Radiology.*
91. CLARK, DANIEL M., Santa Barbara, Calif., *Radiology.*
92. CLARK, JAMES J., Atlanta, Ga., *Roentgenology.*
93. CLARK, STANLEY A., South Bend, Ind., *Radiology.*
94. CLEAVES, EDWIN N., Boston, Mass., *Diagnostic Roentgenology.*
95. CLEGHORN, CHARLES D., Miami, Fla., *Radiology.*
96. CLEMENT, GAGE, Duluth, Minn., *Radiology.*
97. CLEVELAND, WALTER R., Evansville, Ind., *Radiology.*
98. COATE, JOSEPH D., Oakland, Calif., *Radiology.*
99. COE, FREDERICK O., Washington, D.C., *Radiology.*
100. COFFIN, WHITMAN K., Boston, Mass., *Roentgenology.*
101. COHOON, CARL W., Bay Shore, N.Y., *Diagnostic Roentgenology.*
102. COLE, JOHN M., Windsor, Ont., *Roentgenology.*
103. COLE, LEWIS GREGORY, New York, N.Y., *Roentgenology.*
104. COLE, PAUL F., Springfield, Mo., *Radiology.*
105. COLE, WILLIAM GREGORY, New York, N.Y., *Roentgenology.*
106. COLEY, STEPHEN W., Memphis, Tenn., *Roentgenology.*
107. COLLINS, E. N., Cleveland, Ohio, *Diagnostic Roentgenology.*
108. COLLINS, JAMES N., Indianapolis, Ind., *Radiology.*
109. COLLINS, JOHN J., Thomasville, Ga., *Radiology.*
110. COOK, PHILIP H., Worcester, Mass., *Radiology.*
111. COOLEY, RANDALL M., Jackson, Mich., *Diagnostic Roentgenology.*
112. CORAY, Q. B., Salt Lake City, Utah, *Roentgenology.*
113. CORCORAN, WILLIAM J., Scranton, Pa., *Roentgenology.*
114. COSTOLOW, WILLIAM E., Los Angeles, Calif., *Therapeutic Radiology.*
115. CRAIN, CARROLL F., Corpus Christi, Tex., *Radiology.*
116. CRAMP, GEORGE W., Brooklyn, N.Y., *Roentgenology.*
117. CRANE, AUGUSTUS W., Kalamazoo, Mich., *Roentgenology.*
118. CROSSAN, JOHN W., Los Angeles, Calif., *Diagnostic Roentgenology.*
119. CROWDER, E. R., Chicago, Ill., *Roentgenology.*
120. CUNNINGHAM, LESTER W., Mandarin, Fla., *Roentgenology.*
121. CURRIN, FRANCIS W., Brooklyn, N.Y., *Roentgenology.*
122. CUSHWAY, B. C., Chicago, Ill., *Radiology.*

123. Dann, David S., Kansas City, Mo., *Radiology.*
124. Danzer, Joseph T., Oil City, Pa., *Radiology.*
125. Davidson, Sol C., Rochester, N.Y., *Roentgenology.*
126. Davis, Ernest L., Springfield, Mass., *Roentgenology.*
127. Davis, Harold E., Chicago, Ill., *Radiology.*
128. Davis, Henry B., Lancaster, Pa., *Radiology.*
129. Davis, Kenneth S., Los Angeles, Calif., *Roentgenology.*
130. Davison, Chester O., Poughkeepsie, N.Y., *Radiology.*
131. Davison, R. Winthrop, Trenton, N.J., *Roentgenology.*
132. Debbie, Anthony G., St. Albans, N.Y., *Diagnostic Roentgenology.*
133. Decker, Fred H., Peoria, Ill., *Radiology.*
134. Dempster, James H., Detroit, Mich., *Diagnostic Roentgenology.*
135. Derr, John S., Frederick, Md., *Roentgenology.*
136. Desjardins, A. U., Rochester, Minn., *Radiology.*
137. Deweese, Everett R., Kansas City, Mo., *Radiology.*
138. Dick, Paul G., Chicago, Ill., *Roentgenology.*
139. Dickinson, J. C., Tampa, Fla., *Roentgenology.*
140. Dixon, George S., New York, N.Y., *Diagnostic Roentgenology.*
141. Donaldson, S. W., Ann Arbor, Mich., *Roentgenology.*
142. Doub, Howard P., Detroit, Mich., *Radiology.*
143. Doughty, William M., Cincinnati, Ohio, *Radiology.*
144. Downing, Robert E., Terre Haute, Ind., *Diagnostic Roentgenology.*
145. Downs, Elwood E., Woodbury, N.J., *Radiology.*
146. Drane, Robert, Savannah, Ga., *Roentgenology.*
147. Dresser, Richard, Boston, Mass., *Radiology.*
148. Duckworth, Roy D., White Plains, N.Y., *Roentgenology.*
149. Duckworth, Willard D., New Rochelle, N.Y., *Roentgenology.*
150. Dunham, H. Kennon, Cincinnati, Ohio, *Diagnostic Roentgenology.*
151. Durrance, Fred Y., Houston, Tex., *Diagnostic Roentgenology.*
152. Eastmond, Charles, Brooklyn, N.Y., *Roentgenology.*
153. Edeiken, Louis, Philadelphia, Pa., *Radiology.*
154. Edwards, Harold G. F., Shreveport, La., *Radiology.*
155. Edwards, J. Bennett, Englewood, N.J., *Roentgenology.*
156. Ehrenpreis, Bernard, Brooklyn, N.Y., *Roentgenology.*
157. Ehrlich, David E., New York, N.Y., *Diagnostic Roentgenology.*
158. Eldridge, Watson W., Jr., Washington, D.C., *Roentgenology.*
159. Eley, Clayton W., Norfolk, Va., *Roentgenology.*
160. Ellis, Ivan G., Madison, Wis., *Roentgenology.*
161. Elward, Joseph F., Washington, D.C., *Roentgenology.*
162. Eneboe, John B., San Diego, Calif., *Radiology.*
163. Ericksen, Lester G., Dubuque, Iowa, *Radiology.*
164. Ernst, Edwin C., St. Louis, Mo., *Radiology.*
165. Erskine, Arthur W., Cedar Rapids, Iowa, *Radiology.*
166. Evans, William A., Detroit, Mich., *Radiology.*
167. Eveleth, Fred S., Concord, N.H., *Roentgenology.*
168. Exner, Frederick B., Bellingham, Wash., *Radiology.*
169. Farmer, Harry L., Cleveland, Ohio, *Radiology.*
170. Farrell, John T., Jr., Philadelphia, Pa., *Roentgenology.*
171. Feaster, O. O., St. Petersburg, Fla., *Radiology.*
172. Ferguson, James W., Pittsburgh, Pa., *Radiology.*
173. Fineman, Solomon, New York, N.Y., *Roentgenology.*
174. Firor, Whitmer B., Baltimore, Md., *Roentgenology.*
175. Fisher, J. W., Pittsburgh, Pa., *Radiology.*
176. Fisher, Lawrence F., South Bend, Ind., *Roentgenology.*
177. Flinn, F., Decatur, Ill., *Radiology.*
178. Flynn, James M., Rochester, N.Y., *Radiology.*
179. Foley, Joseph M., Chicago, Ill., *Roentgenology.*
180. Ford, Frances A., Detroit, Mich., *Radiology.*
181. Fray, Walter W., Rochester, N.Y., *Radiology.*
182. Freedman, Eugene, Cleveland, Ohio, *Roentgenology.*
183. Freedman, John, Detroit, Mich., *Roentgenology.*
184. Freid, Jacob R., New York, N.Y., *Radiology.*
185. Frere, John M., Chattanooga, Tenn., *Roentgenology.*
186. Fricke, Robert E., Rochester, Minn., *Therapeutic Radiology.*
187. Friedman, Asa B., Brooklyn, N.Y., *Radiology.*
188. Friedman, Harry F., Boston, Mass., *Radiology.*
189. Friedman, Jacob, New York, N.Y., *Roentgenology.*
190. Friedman, Milton, Newark, N.J., *Therapeutic Radiology.*
191. Fruchter, Joseph M., Philadelphia, Pa., *Radiology.*
192. Fugate, Isaac T., Louisville, Ky., *Radiology.*
193. Fulmer, Charles C., San Francisco, Calif., *Roentgenology.*
194. Fulton, Huston F., Columbus, Ohio, *Diagnostic Roentgenology.*
195. Furey, Warren W., Chicago, Ill., *Radiology.*
196. Furst, Nathan J., Newark, N.J., *Diagnostic Roentgenology.*
197. Garland, L. H., San Francisco, Calif., *Radiology.*
198. Gates, Russell, Santa Barbara, Calif., *Roentgenology.*
199. Gemmell, J. H., Philipsburg, Pa., *Roentgenology.*
200. George, Arial W., Boston, Mass., *Roentgenology.*
201. Gerber, Isaac, Providence, R.I., *Radiology.*
202. Gershon-Cohen, Jacob, Philadelphia, Pa., *Radiology.*
203. Geyman, Milton J., Santa Barbara, Calif., *Diagnostic Roentgenology.*
204. Ghrist, David M., Glendale, Calif., *Roentgenology.*
205. Gianturco, Cesare, Urbana, Ill., *Roentgenology.*
206. Giles, Roy G., Temple, Tex., *Roentgenology.*
207. Gillies, Carl L., Iowa City, Iowa, *Radiology.*
208. Gilmore, William M., Stratford, Ont., *Roentgenology.*
209. Gingold, Joseph R., Meadville, Pa., *Roentgenology.*
210. Glover, Milton H., Wichita Falls, Tex., *Radiology.*
211. Goin, Lowell S., Los Angeles, Calif., *Roentgenology.*
212. Golden, Ross, New York, N.Y., *Roentgenology.*
213. Goldsmith, Maurice F., Pittsburgh, Pa., *Roentgenology.*
214. Goodrich, Murray E., Toledo, Ohio, *Radiology.*
215. Goodwin, Perry B., Peoria, Ill., *Radiology.*
216. Gorsline, Clarence S., Battle Creek, Mich., *Roentgenology.*
217. Granger, Amedee, New Orleans, La., *Diagnostic Roentgenology.*
218. Gray, Horace D., Memphis, Tenn., *Radiology.*
219. Grier, George W., Pittsburgh, Pa., *Radiology.*
220. Groeschel, L. B., New York, N.Y., *Radiology.*
221. Groover, Thomas A., Washington, D.C., *Radiology.*
222. Habbe, J. Edwin, Milwaukee, Wis., *Roentgenology.*
223. Hall, E. Walter, Detroit, Mich., *Radiology.*
224. Hall, Wendell C., Philadelphia, Pa., *Radiology.*
225. Hankins, John L., Johnson City, Tenn., *Roentgenology.*
226. Hanson, Cyrus O., Minot, N.D., *Radiology.*
227. Harding, Donnan B., Lexington, Ky., *Radiology.*
228. Hare, Hugh F., Boston, Mass., *Radiology.*
229. Harrington, B. D., Tacoma, Wash., *Radiology.*
230. Harris, Clarence P., Houston, Tex., *Roentgenology.*
231. Harris, John H., Harrisburg, Pa., *Radiology.*
232. Harris, Milo T., Spokane, Wash., *Radiology.*
233. Harris, William, New York, N.Y., *Therapeutic Radiology.*
234. Hartung, Adolph, Chicago, Ill., *Roentgenology.*
235. Hasley, Clyde K., Detroit, Mich., *Radiology.*
236. Hauser, Harry, Cleveland, Ohio, *Radiology.*
237. Hawley, Sydney J., Danville, Pa., *Roentgenology.*
238. Haworth, Wallace, Portland, Ore., *Radiology.*
239. Hay, Percy D., Jr., Florence, S.C., *Radiology.*
240. Heacock, Charles H., Memphis, Tenn., *Roentgenology.*
241. Healy, Thomas R., Boston, Mass., *Roentgenology.*
242. Heatley, John E., Oklahoma City, Okla., *Diagnostic Roentgenology.*
243. Heberding, John, Youngstown, Ohio, *Radiology.*
244. Hefke, Hans W., Milwaukee, Wis., *Radiology.*
245. Hendricks, Elliott M., Fort Lauderdale, Fla., *Roentgenology.*
246. Hendrickson, Anna R., Canton, Ohio, *Roentgenology.*
247. Henry, Lucas S., Syracuse, N.Y., *Roentgenology.*
248. Herpel, Frederick K., West Palm Beach, Fla., *Roentgenology.*
249. Herrmann, William G., Asbury Park, N.J., *Radiology.*
250. Hess, George H., Uniontown, Pa., *Roentgenology.*
251. Heylmun, Harry H., Long Beach, Calif., *Diagnostic Roentgenology.*
252. Hill, Harold A., San Francisco, Calif., *Radiology.*

253. HILL, WALTER C., Cleveland, Ohio, *Roentgenology.*
254. HILT, LAWRENCE M., Springfield, Ill., *Roentgenology.*
255. HILTON, JAMES M., Klamath Falls, Ore., *Roentgenology.*
256. HIRSCH, I. SETH, New York, N.Y., *Radiology.*
257. HODGES, FRED J., Ann Arbor, Mich., *Radiology.*
258. HODGES, FRED M., Richmond, Va., *Radiology.*
259. HODGES, PAUL C., Chicago, Ill., *Radiology.*
260. HOFFMAN, WILLIAM J., New York, N.Y., *Therapeutic Radiology.*
261. HOLLY, LELAND E., Muskegon, Mich., *Roentgenology.*
262. HOLMES, GEORGE W., Boston, Mass., *Radiology.*
263. HOLMES, RALPH W., Chillicothe, Ohio, *Roentgenology.*
264. HOLSTON, JOEL D., Massillon, Ohio, *Roentgenology.*
265. HOPKIRK, C. C., Santa Monica, Calif., *Roentgenology.*
266. HORRIGAN, ARTHUR J., Springfield, Mass., *Roentgenology.*
267. HOWARD, WILLIAM P., Albany, N.Y., *Roentgenology.*
268. HOWES, WILLIAM E., Brooklyn, N.Y., *Radiology.*
269. HUBENY, M. J., Chicago, Ill., *Roentgenology.*
270. HUFFORD, CLARENCE E., Toledo, Ohio, *Radiology.*
271. HUNT, HOWARD B., Omaha, Neb., *Radiology.*
272. HUNT, RUSSELL R., Providence, R.I., *Roentgenology.*
273. HUNTER, JAMES W., JR., Norfolk, Va., *Radiology.*
274. HUTTON, FREDERICK C., Philadelphia, Pa., *Roentgenology.*
275. HYNES, WILLIAM P., Washington, D.C., *Therapeutic Radiology.*
276. IKEDA, KANO, St. Paul, Minn., *Roentgenology.*
277. ILLICK, H. EARL, New York, N.Y., *Roentgenology.*
278. IMBODEN, HARRY M., New York, N.Y., *Roentgenology.*
279. INGBER, IRVING S., San Francisco, Calif., *Radiology.*
280. IVEY, H. B., Goldsboro, N.C., *Radiology.*
281. JACHES, LEOPOLD, New York, N.Y., *Radiology.*
282. JACKSON, BYRON H., Scranton, Pa., *Radiology.*
283. JACKSON, JOHN B., Kalamazoo, Mich., *Roentgenology.*
284. JACOBS, LEWIS G., JR., San Francisco, Calif., *Radiology.*
285. JACOX, HAROLD W., Ann Arbor, Mich., *Radiology.*
286. JARRE, HANS A., Detroit, Mich., *Radiology.*
287. JENKINSON, DAVID L., Chicago, Ill., *Roentgenology.*
288. JENKINSON, E. L., Chicago, Ill., *Radiology.*
289. JOHANNESSON, CARL J., Walla Walla, Wash., *Roentgenology.*
290. JOHNSON, CLAYTON R., Los Angeles, Calif., *Roentgenology.*
291. JOHNSON, ELLSWORTH, Winchester, Va., *Roentgenology.*
292. JOHNSON, JESSE B., Galveston, Tex., *Radiology.*
293. JOHNSON, VINCENT C., Ann Arbor, Mich., *Radiology.*
294. JOHNSTON, ZOE ALLISON, Pittsburgh, Pa., *Therapeutic Radiology.*
295. JONES, HORACE C., Detroit, Mich., *Radiology.*
296. JONES, WILLIAM A., Kingston, Ont., *Radiology.*
297. JUDY, WILLIAM S., Greenville, S.C., *Radiology.*
298. KABAKJIAN, ARMEN E., Lancaster, Pa., *Radiology.*
299. KAHN, MAX, Baltimore, Md., *Roentgenology.*
300. KALBFLEISCH, WILLIAM K., Wheeling, W.Va., *Roentgenology.*
301. KANN, U. S., Binghamton, N.Y., *Radiology.*
302. KAPLAN, IRA I., New York, N.Y., *Therapeutic Radiology.*
303. KAPLAN, MORRIS, New York, N.Y., *Diagnostic Roentgenology.*
304. KASABACH, HAIG H., New York, N.Y., *Radiology.*
305. KEICHLINE, JOHN M., Huntingdon, Pa., *Radiology.*
306. KEITH, DAVID Y., Louisville, Ky., *Radiology.*
307. KELLY, JAMES F., Omaha, Neb., *Radiology.*
308. KENNING, JOHN C., Detroit, Mich., *Radiology.*
309. KERBY, JAMES P., Salt Lake City, Utah, *Roentgenology.*
310. KERR, H. DABNEY, Iowa City, Iowa, *Radiology.*
311. KESMODEL, KARL F., Birmingham, Ala., *Radiology.*
312. KIDDER, FRANK W., Los Angeles, Calif., *Diagnostic Roentgenology.*
313. KINNEY, LYELL C., San Diego, Calif., *Radiology.*
314. KIRLAND, A. STANLEY, St. John, N.B., *Roentgenology.*
315. KIRKLIN, B.R., Rochester, Minn., *Radiology.*
316. KLEIN, WILLIAM, New Brunswick, N.J., *Radiology.*
317. KOIRANSKY, GENNADY H., Long Island City, N.Y., *Diagnostic Roentgenology.*
318. KOLVOORD, THEODORE, Battle Creek, Mich., *Diagnostic Roentgenology.*
319. KORNBLUM, KARL, Philadelphia, Pa., *Radiology.*
320. KUEGLE, F. H., Janesville, Wis., *Roentgenology.*
321. LAFFERTY, R. H., Charlotte, N.C., *Radiology.*
322. LANDAU, GEORGE M., Chicago, Ill., *Roentgenology.*
323. LANDES, W. L. S., York, Pa., *Roentgenology.*
324. LANGAN, PAUL C., Akron, Ohio, *Diagnostic Roentgenology.*
325. LANGE, SIDNEY, Cincinnati, Ohio, *Radiology.*
*326. LANGER, HEINZ, Pittsburgh, Pa., *Therapeutic Radiology.*
327. LARKEY, CHARLES J., Bayonne, N.J., *Diagnostic Roentgenology.*
328. LATTMAN, ISIDORE, Washington, D.C., *Radiology.*
329. LAW, F. M., New York, N.Y., *Diagnostic Roentgenology.*
330. LAWRENCE, W. S., Memphis, Tenn., *Radiology.*
331. LAWSON, JOHN D., Sacramento, Calif., *Radiology.*
332. LEDDY, EUGENE T., Rochester, Minn., *Radiology.*
333. LEDOUX, ALFRED C., Evanston, Ill., *Radiology.*
334. LEEF, EDWARD, San Francisco, Calif., *Radiology.*
335. LEFEVRE, WALTER I., Cleveland, Ohio, *Roentgenology.*
336. LEIBERT, HARRY F., Bethlehem, Pa., *Roentgenology.*
337. LENZ, MAURICE, New York, N.Y., *Therapeutic Radiology.*
338. LEONARD, RALPH D., Boston, Mass., *Roentgenology.*
339. LEUCUTIA, T., Detroit, Mich., *Radiology.*
340. LEVENE, GEORGE, Boston, Mass., *Roentgenology.*
341. LEVI, IRWIN P., Anniston, Ala., *Roentgenology.*
342. LE VINE, DAVID, El Dorado, Ark., *Diagnostic Roentgenology.*
343. LEVINE, SAMUEL, Philadelphia, Pa., *Radiology.*
344. LEVITIN, JOSEPH, San Francisco, Calif., *Radiology.*
345. LEVYN, LESTER, Buffalo, N.Y., *Diagnostic Roentgenology.*
346. LEWIS, RAYMOND W., New York, N.Y., *Diagnostic Roentgenology.*
347. LHEVINE, MORRIS B., Tulsa, Okla., *Roentgenology.*
348. LIEBMAN, CHARLES, Montreal, Que., *Roentgenology.*
349. LILJEDAHL, ELMER N., Los Angeles, Calif., *Roentgenology.*
350. LINGEMAN, LESLIE R., Rochester, N.Y., *Roentgenology.*
351. LIPSCHULTZ, OSCAR, Minneapolis, Minn., *Roentgenology.*
352. LITSCHGI, JOSEPH J., Chicago, Ill., *Roentgenology.*
353. LITTIG, LAWRENCE V., Madison, Wis., *Radiology.*
354. LOCHRY, RALPH L., Indianapolis, Ind., *Roentgenology.*
355. LOCKWOOD, IRA H., Kansas City, Mo., *Radiology.*
356. LOUD, NORMAN W., New Britain, Conn., *Diagnostic Roentgenology.*
357. LUCINIAN, JOSEPH H., Miami, Fla., *Roentgenology.*
358. LUTZ, JEREMIAH F., York, Pa., *Roentgenology.*
359. MACCOLL, D. R., Los Angeles, Calif., *Roentgenology.*
360. MACMILLAN, A. S., Boston, Mass., *Diagnostic Roentgenology.*
361. MCCARTHY, JUSTIN E., Cincinnati, Ohio., *Radiology.*
362. MCCAW, WILLIAM W., Washington, D.C., *Radiology.*
363. MCCLANAHAN, CHARLES W., West Los Angeles, Calif., *Radiology.*
364. MCCLELLAND, DONALD C., Lafayette, Ind., *Radiology.*
365. MCCLURE, CHRISTOPHER C., Nashville, Tenn., *Radiology.*
366. MCCORMICK, ARTHUR F., Du Bois, Pa., *Roentgenology.*
367. MCCORMICK, H. G., Laurel, Miss., *Roentgenology.*
368. MCCORMICK, WILLIAM M., Du Bois, Pa., *Roentgenology.*
369. MCCULLOUGH, JOHN F., Pittsburgh, Pa., *Radiology.*
370. MCDEED, WINFIELD G., Houston, Tex., *Roentgenology.*
371. MCDERMOTT, JOSEPH L., Kansas City, Mo., *Radiology.*
372. MCELFATRICK, GEORGE C., Wilmington, Del., *Roentgenology.*
373. MCEUEN, HARRY B., Jacksonville, Fla., *Radiology.*
374. MCGEE, HARRY H., Savannah, Ga., *Roentgenology.*
375. MCGEHEE, WILLIAM H., Fresno, Calif., *Roentgenology.*
376. MCGUFFIN, W. HERBERT, Calgary, Alberta, *Radiology.*
377. MCHENRY, RUPERT K., Houston, Tex., *Roentgenology.*
378. MCINTOSH, HARRIET C., New York, N.Y., *Roentgenology.*
379. MCKINNEY, JOSEPH T., Roanoke, Va., *Roentgenology.*
380. MCNABB, ATHOLL M., Ottawa, Ont., *Roentgenology.*
381. MCNAMEE, EDGAR P., Cleveland, Ohio, *Diagnostic Roentgenology.*
382. MCNUTT, JOHN R., Duluth, Minn., *Radiology.*
383. MCPEAK, CLARENCE N., Fitchburg, Mass., *Roentgenology.*
384. MCPEAK, EDGAR M., Washington, D.C., *Radiology.*
385. MAGRUDER, L. FREELAND, Norfolk, Va., *Radiology.*

386. Mahrer, Herbert A., Cleveland, Ohio, *Diagnostic Roentgenology.*
387. Maier, Roe J., Chicago, Ill., *Radiology.*
388. Malcolmson, Patrick H., Edmonton, Alberta, *Radiology.*
389. Malone, Leander A., Terre Haute, Ind., *Radiology.*
390. Mandeville, Frederick B., Richmond, Va., *Roentgenology.*
391. Manges, Willis F., Philadelphia, Pa., *Radiology.*
392. Marchbanks, Stanton S., Chattanooga, Tenn., *Radiology.*
393. Marks, Joseph H., Fall River, Mass., *Roentgenology.*
394. Marquis, W. James, Newark, N.J., *Roentgenology.*
395. Martin, Charles L., Dallas, Tex., *Radiology.*
396. Martin, James M., Dallas, Tex., *Radiology.*
397. Martin, William C., Louisville, Ky., *Roentgenology.*
398. Mason, Claude H., El Paso, Tex., *Diagnostic Roentgenology.*
399. Masterson, John J., Brooklyn, N.Y., *Roentgenology.*
400. Mattick, Walter L., Buffalo, N.Y., *Therapeutic Radiology.*
401. Maver, William W., Jersey City, N.J., *Roentgenology.*
402. Mawhinney, Harvey N., Pittsburgh, Pa., *Diagnostic Roentgenology.*
403. May, Ernst A., East Orange, N.J., *Radiology.*
404 May, Raymond V., Cleveland, Ohio, *Radiology.*
405. May, Robert J., Cleveland, Ohio, *Radiology.*
406. Mayfield, Claud, Long Beach, Calif., *Diagnostic Roentgenology.*
407. Meadows, James A., Birmingham, Ala., *Radiology.*
408. Medelman, John P., Lubbock, Tex., *Roentgenology.*
409. Meland, Orville N., Los Angeles, Calif., *Therapeutic Radiology.*
410. Mendelson, Emanuel, Brooklyn, N.Y., *Roentgenology.*
411. Menees, Thomas O., Grand Rapids, Mich., *Radiology.*
412. Menville, Leon J., New Orleans, La., *Radiology.*
413. Merchant, Albert K., Philadelphia, Pa., *Radiology.*
414. Merrill, E. Forrest, New York, N.Y., *Roentgenology.*
415. Meyer, Keith T., Evansville, Ind., *Roentgenology.*
416. Meyer, William H., New York, N.Y., *Radiology.*
417. Milkman, Louis A., Scranton, Pa., *Roentgenology.*
418. Millwee, Robert H., Dallas, Tex., *Radiology.*
419. Ming, Charles M., Okmulgee, Okla., *Radiology.*
420. Minor, Edward G., Detroit, Mich., *Diagnostic Roentgenology.*
421. Moloney, Albert M., Boston, Mass., *Roentgenology.*
422. Moore, Alexander B., Washington, D.C., *Radiology.*
423. Moore, Claude, Washington, D.C., *Radiology.*
424. Moore, Daniel M., Monroe, La., *Roentgenology.*
425. Moore, John J., San Francisco, Calif., *Radiology.*
426. Moore, Paul D., Muncie, Ind., *Radiology.*
427. Moore, Sherwood, St. Louis, Mo., *Radiology.*
428. Moore, Vernor M., Grand Rapids, Mich., *Radiology.*
429. Morrison, Murray C., London, Ont., *Radiology.*
430. Morrison, Sidney L., Boston, Mass., *Roentgenology.*
431. Morse, Russell W., Minneapolis, Minn., *Roentgenology.*
432. Morton, S. A., Milwaukee, Wis., *Radiology.*
433. Moxness, Bennie A., Coatesville, Pa., *Diagnostic Roentgenology.*
434. Mulligan, Peter B., Ashland, Pa., *Roentgenology.*
435. Murphy, G. W., Asheville, N.C., *Roentgenology.*
436. Murphy, John T., Toledo, Ohio, *Radiology.*
437. Myers, Ralph E., Oklahoma City, Okla., *Radiology.*
438. Nathanson, Louis, Brooklyn, N.Y., *Radiology.*
439. Nessa, N.J., Sioux Falls, S.D., *Roentgenology.*
440. Newcomet, William S., Philadelphia, Pa., *Radiology.*
441. Newell, Robert R., San Francisco, Calif., *Radiology.*
442. Nichols, Bernard H., Cleveland, Ohio, *Radiology.*
443. Nichols, Harold E., Seattle, Wash., *Diagnostic Roentgenology.*
444. Nordin, Gustaf T., Minneapolis, Minn., *Radiology.*
445. O'Boyle, Cyril P., Philadelphia, Pa., *Diagnostic Roentgenology.*
446. O'Brien, Frederick W., Boston, Mass., *Radiology.*
447. O'Connell, Andrew E., Worcester, Mass., *Roentgenology.*
448. O'Neill, John R., San Francisco, Calif., *Roentgenology.*
449. Oechsli, Waldo R., Olive View, Calif., *Diagnostic Roentgenology.*
450. Ogden, Ralph T., Hartford, Conn., *Radiology.*
451. Olin, Harry, Chicago, Ill., *Roentgenology.*
452. Orndoff, Benjamin H., Chicago, Ill., *Radiology.*
453. Orr, Clifford R., Buffalo, N.Y., *Radiology.*
454. Osmond, John D., Cleveland, Ohio, *Roentgenology.*
455. Osmond, Leslie H., Pittsburgh, Pa., *Radiology.*
456. Ostrum, Herman W., Philadelphia, Pa., *Roentgenology.*
457. Ourian, Adom K., New York, N.Y., *Diagnostic Roentgenology.*
458. Overgaard, Anders P., Omaha, Neb., *Radiology.*
459. Owen, Arthur K., Topeka, Kan., *Roentgenology.*
460. Owen, Colin C., San Bernardino, Calif., *Roentgenology.*
*461. Paine, Robert, Memphis, Tenn., *Radiology.*
462. Pallen, Conde deS., Rochelle Park, N.J., *Therapeutic Radiology.*
463. Palmer, Dorwin L., Portland, Ore., *Radiology.*
464. Pancoast, Henry K., Philadelphia, Pa., *Radiology.*
465. Parker, Carl H., Pasadena, Calif., *Roentgenology.*
*466. Parry, Leo D., Easton, Pa., *Radiology.*
467. Paul, Lester W., Madison, Wis., *Diagnostic Roentgenology.*
468. Pawling, Jesse R., Watertown, N.Y., *Diagnostic Roentgenology.*
469. Peden, Joseph C., St. Louis, Mo., *Roentgenology.*
470. Peirce, Carleton B., Ann Arbor, Mich., *Radiology.*
471. Pendergrass, E.P., Philadelphia, Pa., *Radiology.*
472. Pendergrass, Robert C., Americus, Ga., *Roentgenology.*
473. Percival, Milton F., Philadelphia, Pa., *Radiology.*
474. Perkins, Charles W., Norwalk, Conn., *Roentgenology.*
475. Perry, Gentz, Evanston, Ill., *Radiology.*
476. Peters, Chester M., Canton, Ohio, *Radiology.*
477. Peterson, Charles H., Roanoke, Va., *Roentgenology.*
478. Peterson, Vernon L., Charleston, W.Va., *Radiology.*
479. Pfahler, George E., Philadelphia, Pa., *Radiology.*
480. Phillips, Clyde C., Charlotte, N.C., *Radiology.*
481. Pierce, Harold J., Terre Haute, Ind., *Radiology.*
482. Pierson, John W., Baltimore, Md., *Radiology.*
483. Pindell, Merl L., Los Angeles, Calif., *Diagnostic Roentgenology.*
484. Pines, John A., Orlando, Fla., *Therapeutic Roentgenology.*
485. Pirie, Alexander H., Montreal, Que., *Radiology.*
486. Pitts, Thomas A., Columbia, S.C., *Roentgenology.*
*487. Podlasky, Harry B., Milwaukee, Wis., *Roentgenology.*
488. Pohle, E. A., Madison, Wis., *Therapeutic Radiology.*
489. Pomeranz, Maurice M., New York, N.Y., *Radiology.*
490. Pomeranz, Raphael, Newark, N.J., *Roentgenology.*
491. Pomeroy, Lawrence A., Cleveland, Ohio, *Radium Therapy.*
492. Porter, Horace W., Jackson, Mich., *Radiology.*
493. Portmann, U. V., Cleveland, Ohio, *Radiology.*
494. Post, Joseph W., Philadelphia, Pa., *Diagnostic Roentgenology.*
495. Potter, Carlton F., Syracuse, N.Y., *Roentgenology.*
496. Potter, Hollis E., Chicago, Ill., *Roentgenology.*
497. Potter, Roy P., Marshfield, Wis., *Roentgenology.*
498. Pound, Robert E., New York, N.Y., *Roentgenology.*
499. Powers, Martin T., Utica, N.Y., *Diagnostic Roentgenology.*
500. Powers, Robert A., Palo Alto, Calif., *Radiology.*
501. Prouty, J. V., Terre Haute, Ind., *Radiology.*
502. Putts, B. Swayne, Erie, Pa., *Roentgenology.*
503. Quick, Douglas, New York, N.Y., *Therapeutic Radiology.*
504. Quimby, A. Judson, New York, N.Y., *Roentgenology.*
505. Quiney, James J., Easton, Pa., *Radiology.*
506. Quinlan, Catherine M., Santa Rosa, Calif., *Roentgenology.*
507. Raap, Gerard, Miami, Fla., *Radiology.*
508. Radding, Moses B., Elizabeth, N.J., *Diagnostic Roentgenology.*
509. Rathbone, Ralph R., Washington, D.C., *Radiology.*
510. Rauschenbach, Charles W., Hammond, Ind., *Roentgenology.*
511. Ravold, Henry J., St. Joseph, Mo., *Radiology.*

512. RAY, WILLIAM B. G., Pittsburgh, Pa., *Roentgenology.*
513. REAVES, HUGH G., Knoxville, Tenn., *Roentgenology.*
514. REED, CHARLES B., Newburgh, N.Y., *Roentgenology.*
515. REEVES, ROBERT J., Durham, N.C., *Radiology.*
516. REILEY, WILLIAM E., Clearfield, Pa., *Radiology.*
517. REINEKE, HAROLD G., Cincinnati, Ohio, *Roentgenology.*
518. REITTER, GEORGE S., East Orange, N.J., *Radiology.*
519. REMER, JOHN, New York, N.Y., *Therapeutic Roentgenology.*
520. RENDICH, RICHARD A., Brooklyn, N.Y., *Roentgenology.*
521. REYNOLDS, LAWRENCE, Detroit, Mich., *Radiology.*
522. RHINEHART, DARMON A., Little Rock, Ark., *Roentgenology.*
523. RHUDY, BOOKER E., Greensboro, N.C., *Roentgenology.*
524. RICE, FRANK M., San Francisco, Calif., *Roentgenology.*
525. RIGLER, LEO G., Minneapolis, Minn., *Radiology.*
526. RITVO, MAX, Boston, Mass., *Radiology.*
527. RITZMAN, ALLEN Z., Harrisburg, Pa., *Roentgenology.*
528. ROBIN, NATHANIEL H., Hempstead, N.Y., *Roentgenology.*
529. ROBIN, PERCIVAL A., Hempstead, N.Y., *Roentgenology.*
530. ROBINS, SAMUEL A., Boston, Mass., *Roentgenology.*
*531. ROBINSON, RALPH V., Pittsburgh, Pa., *Roentgenology.*
532. ROBINSON, WALTER W., Memphis, Tenn., *Roentgenology.*
533. RODENBAUGH, FREDERICK H., San Francisco, Calif., *Radiology.*
534. RODGERS, FLOYD D., Columbia, S.C., *Radiology.*
535. RODRIGUEZ, JUAN, Fort Wayne, Ind., *Radiology.*
*536. ROLAND, MARION M., Oklahoma City, Okla., *Therapeutic Radiology.*
537. ROSE, CASSIE B., Chicago, Ill., *Radiology.*
538. ROSENBAUM, GEORGE, Philadelphia, Pa., *Diagnostic Roentgenology.*
539. ROSH, RIEVA, New York, N.Y., *Therapeutic Radiology.*
540. ROUSSEAU, J. P., Winston Salem, N.C., *Radiology.*
541. ROWE, EDWARD W., Lincoln, Neb., *Radiology.*
542. ROWELL, EDWARD E., Stamford, Conn., *Roentgenology.*
543. RUBERT, SAMUEL R., Chicago, Ill., *Diagnostic Roentgenology.*
544. RUDISILL, HILLYER JR., Charleston, S.C., *Radiology.*
545. RUGGLES, HOWARD E., San Francisco, Calif., *Roentgenology.*
546. RUTLEDGE, CLIFFORD P., Shreveport, La., *Radiology.*
547. RYPINS, EDWIN L., Bloomington, Ill., *Radiology.*
548. SANDERSON, STEVENS S., Detroit, Mich., *Radiology.*
549. SANTE, L. R., St. Louis, Mo., *Radiology.*
550. SCHIMMELPFENNIG, R.D., Montclair, N.J., *Roentgenology.*
551. SCHMITZ, HENRY, Chicago, Ill., *Therapeutic Radiology.*
552. SCHNOEBELEN, PAUL C., St. Louis, Mo., *Roentgenology.*
553. SCHONS, EDWARD, St. Paul, Minn., *Radiology.*
554. SCHUMACHER, F. L., Pittsburgh, Pa., *Radiology.*
555. SCHWARTZ, CHARLES W., New York, N.Y., *Roentgenology.*
556. SCHWARTZ, IRVING, New York, N.Y., *Diagnostic Roentgenology.*
557. SHARPE, A. MAXWELL, Chester, Pa., *Roentgenology.*
558. SHAW, WILFRED McL., Jacksonville, Fla., *Roentgenology.*
559. SHEBESTA, EMIL M., Detroit, Mich., *Radiology.*
560. SHELDON, FRANCIS B., Stockton, Calif., *Radiology.*
561. SHERIDAN, WILLIAM M., Spartanburg, S.C., *Radiology.*
562. SHERMAN, HERBERT DEG., White Plains, N.Y., *Diagnostic Roentgenology.*
563. SHERRICK, EARL C., Connellsville, Pa., *Diagnostic Roentgenology.*
564. SHIFLETT, E. LEE, Indianapolis, Ind., *Roentgenology.*
565. SHORE, O. J., Detroit, Mich., *Diagnostic Roentgenology.*
566. SHOULDERS, H. S., Nashville, Tenn., *Radiology.*
567. SICHLER, HARPER G., Lafayette, Ind., *Radiology.*
568. SICKELS, THOMAS N., Watertown, N.Y., *Roentgenology.*
569. SIEFERT, ALFRED C., Oakland, Calif., *Radiology.*
570. SIGMAN, FREDERICK G., Salisbury, N.C., *Roentgenology.*
571. SIMS, GEORGE P., Columbus, Ohio, *Therapeutic Radiology.*
572. SKINNER, EDWARD H., Kansas City, Mo., *Radiology.*
573. SKOMP, C. E., Denver, Colo., *Diagnostic Roentgenology.*
574. SMITH, ARTHUR B., La Jolla, Calif., *Diagnostic Roentgenology.*
575. SMITH, LESTER A., Indianapolis, Ind., *Radiology.*
576. SMITH, RICHARD L., Grand Rapids, Mich., *Radiology.*
577. SMITH, R. MANGES, Philadelphia, Pa., *Roentgenology.*
578. SMITH, ROSCOE L., Lincoln, Nebr., *Radiology.*
579. SMYTH, THOMAS L., Allentown, Pa., *Roentgenology.*
580. SNEAD, LAWRENCE O., Richmond, Va., *Roentgenology.*
581. SNOW, HENRY, Dayton, Ohio, *Radiology.*
582. SNOW, WILLIAM, New York, N.Y., *Roentgenology.*
583. SNURE, HENRY, Los Angeles, Calif., *Roentgenology.*
584. SOILAND, ALBERT, Los Angeles, Calif., *Radiology.*
585. SOLIS-COHEN, LEON, Philadelphia, Pa., *Radiology.*
586. SOSMAN, M. C., Boston, Mass., *Radiology.*
587. SOULE, ARTHUR B., JR., Burlington, Vt., *Roentgenology.*
588. SPACKMAN, EDGAR W., Philadelphia, Pa., *Radiology.*
589. SPANGLER, DAVIS, Dallas, Tex., *Radiology.*
590. SPENCER, HUNTER B., Lynchburg, Va., *Roentgenology*
591. SPILMAN, HAROLD A., Ottumwa, Ia., *Roentgenology.*
592. SPINZIG, EDGAR W., St. Louis, Mo., *Radiology.*
593. SPROULL, JOHN, Haverhill, Mass., *Roentgenology.*
594. STAFFORD, OWEN R., Los Angeles, Calif., *Therapeutic Roentgenology.*
595. STALL, ARTHUR H., Akron, Ohio, *Radiology.*
596. STAMMEL, CHARLES A., Washington, D.C., *Diagnostic Roentgenology.*
597. STARKS, DOROTHY J., Palo Alto, Calif., *Radiology.*
598. STARTZ, IRVING S., Elmhurst, N.Y., *Roentgenology.*
599. STAYTON, CHESTER A., Indianapolis, Ind., *Roentgenology.*
600. STECHER, WILLIAM R., Darby, Pa., *Radiology.*
601. STEEL, DAVID, Cleveland, Ohio, *Roentgenology.*
602. STEINER, JOSEPH M., New York, N.Y., *Roentgenology.*
603. STEPHENSON, F. B., Denver, Colo., *Radiology.*
604. STEVENS, ROLLIN H., Detroit, Mich., *Radiology.*
605. STEWART, HARRY M., Johnstown, Pa., *Radiology.*
606. STEWART, WENDELL, East St. Louis, Ill., *Diagnostic Roentgenology.*
607. STEWART, WILLIAM H., New York, N.Y., *Roentgenology.*
608. STONE, ROBERT S., San Francisco, Calif., *Roentgenology.*
609. STUART, LEON H., Tulsa, Okla., *Roentgenology.*
610. SUTHERLAND, CHARLES G., Rochester, Minn., *Diagnostic Roentgenology.*
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612. SWOPE, OPIE W., Wichita, Kan., *Radiology.*
613. TABB, JOHN L., JR., Richmond, Va., *Roentgenology.*
614. TAFT, ROBERT B., Charleston, S.C., *Radiology.*
615. TALLEY, DANIEL D., JR., Richmond, Va., *Roentgenology.*
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640. VAN NUYS, ROSCOE G., Berkeley, Calif., *Radiology.*
641. VASTINE, JACOB H., Philadelphia, Pa., *Radiology.*
642. VELKOFF, METODI, Fort Wayne, Ind., *Roentgenology.*
643. VIRDEN, C. EDGAR, Kansas City, Mo., *Radiology.*
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645. VOKE, EDWARD L., Akron, Ohio, *Diagnostic Roentgenology.*

646. Voltz, Albert L., Richmond Hill, N.Y., *Roentgenology*.
647. von Poswick, Gisela, Scranton, Pa., *Roentgenology*.
648. Wachowski, T. J., Chicago, Ill., *Roentgenology*.
649. Walton, Henry J., Baltimore, Md., *Radiology*.
650. Warfield, Chester H., Chicago, Ill., *Roentgenology*.
651. Warren, Alva H., Malden, Mass., *Diagnostic Roentgenology*.
652. Wasson, W. W., Denver, Colo., *Radiology*.
653. Waters, Charles A., Baltimore, Md., *Radiology*.
654. Watkins, W. Warner, Phoenix, Ariz., *Radiology*.
655. Weaver, Clarence E., Detroit, Mich., *Roentgenology*.
656. Webb, James A. H., Wichita, Kan., *Roentgenology*.
657. Weber, Harry M., Rochester, Minn., *Roentgenology*.
658. Weeks, Paul R., Denver, Colo., *Radiology*.
659. Weiskotten, W. Otto, San Diego, Calif., *Roentgenology*.
660. Weitzner, Imre, New York, N.Y., *Diagnostic Roentgenology*.
661. Weitzner, Samuel F., New York, N.Y., *Diagnostic Roentgenology*.
662. Wescott, William C., Atlantic City, N.J., *Radiology*.
663. West, James H., Cleveland, Ohio, *Radiology*.
664. West, Theodore S., Port Chester, N.Y., *Roentgenology*.
665. Wheatley, Frank E., Boston, Mass., *Radiology*.
666. Wheatley, Louis F., New Haven, Conn., *Roentgenology*.
667. Whelan, Charles, Boston, Mass., *Radiology*.
668. Whitehead, Lawther J., Richmond, Va., *Roentgenology*.
669. Whitlock, Simon B., Norfolk, Va., *Roentgenology*.
670. Widmann, Bernard P., Philadelphia, Pa., *Radiology*.
671. Wigby, Palmer E., Dallas, Tex., *Radiology*.
672. Wilcox, Clark A., Wichita Falls, Tex., *Radiology*.
673. Williams, Arthur J., San Francisco, Calif., *Radiology*.
674. Williams, Francis H., Boston, Mass., *Radiology*.
675. Williams, Lester J., Baton Rouge, La., *Radiology*.
676. Williams, Percival A., Hempstead, N.Y., *Diagnostic Roentgenology*.
677. Willy, Ralph G., Chicago, Ill., *Roentgenology*.
678. Wilson, Hugh M., New Haven, Conn., *Roentgenology*.
679. Wilson, James E., Clarksburg, W.Va., *Diagnostic Roentgenology*.
680. Wilson, Rabun T., Temple, Tex., *Roentgenology*.
681. Wilson, Stanley A., Lewiston, Me., *Roentgenology*.
682. Withers, Sanford M., Denver, Colo., *Therapeutic Radiology*.
683. Witwer, Eldwin R., Detroit, Mich., *Radiology*.
684. Woolford, Joseph S., Eureka, Calif., *Therapeutic Radiology*.
685. Wright, Cecil S., Indianapolis, Ind., *Radiology*.
686. Wurster, Lloyd E., Williamsport, Pa., *Roentgenology*.
687. Young, Barton R., Philadelphia, Pa., *Radiology*.
688. Zink, Oscar C., St. Louis, Mo., *Radiology*.
689. Zulick, J. Donald, Philadelphia, Pa., *Roentgenology*.

* Deceased.

There will be two meetings of the American Board of Radiology in 1936 for the purpose of conducting examinations, one in Kansas City, Missouri, in May, just preceding the meeting of the American Medical Association, and the other in Cleveland, Ohio, in September, preceding the meeting of the American Roentgen Ray Society. Any applicant wishing to be assured of an appointment to appear before the Board in Kansas City should have his application on file in this office not later than March 1, 1936.

B. R. Kirklin, M. D.
Secretary-Treasurer,
American Board of Radiology

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Radium Treatment of Skin Diseases, New Growths, Diseases of the Eyes, and Tonsils. By Francis H. Williams, M.D. (Harv.), S.B. Massachusetts Institute of Technology; Senior Physician Boston City Hospital; Fellow American Academy of Arts and Sciences; Emeritus Member Association American Physicians; Member Société de Radiologie Médicale de France; Corresponding Member K. K. Gesellschaft der Aerzte in Wien, etc. Cloth. Price, $2.00. Pp. 118, with 12 illustrations. Boston: The Stratford Company, 1935.

This small volume of slightly more than one hundred pages is rather unusual in that it summarizes work done with small, lightly filtered radium plaques over a period of thirty years by a man who has been little influenced by the trend of the rest of the world towards interstitial irradiation and the use of highly filtered gamma rays. His individuality is illustrated by his bibliography which lists only five articles other than those coming from his own pen.

The first section deals briefly with radium physics and is of interest because it describes a method for estimating depth doses from penetration curves prepared many years ago with an instrument called a fluorometer. Readings were obtained by placing the unknown source of radiation at a distance from a fluorescent screen sufficient to cause its fluorescence to equal that produced by a known quantity of radium placed at a known distance. Data obtained in this way were probably not very accurate but they formed the basis for the author's plan of therapy.

A group of skin malignancies treated with radium plaques is reported and although the number showing primary healing is large, few five year cures are reported. Apparently because of the lack of proper measuring instruments the unfortunate conclusion is reached that radium is more efficient than roentgen rays in the treatment of skin diseases. The inadequacy of radium plaques in dealing with cancer of the mouth, throat and cervical lymph nodes is noted but nothing is said of the recent important advances made with interstitial sources.

The second section is the most valuable portion of the book. It deals with the use of radium plaques in ophthalmology, and a very practical applicator for this rather difficult type of work is described. Many case reports illustrating good results obtained with new growths of the lids, ectropion, corneal opacities, cataract and retinitis pigmentosa are cited. The doses advocated are small and are repeated at intervals for long periods of time. The value of this chapter would be much enhanced if the author had described the conjunctivitis, opacities of the lens and other ill effects that may follow radium overdosage.

The third section covers the treatment of tonsillitis and diseased lymphoid tissue in the throat. Round radium plaques on the ends of long rods designed for direct application to the involved areas are described. Many case histories of patients claiming marked relief of subjective symptoms following treatment are given in detail, and decided improvement in several cases of arthritis is attributed to shrinkage of diseased tonsils following contact irradiation.

Although this little book contains some inaccuracies every radiologist can profit by a study of the observations of a pioneer in the field who has continued to use beta rays while his confrères have directed most of their attention to gamma irradiation.

Charles L. Martin

Das Ventrikulogramm. III. Teil. Dritter und vierter Ventrikel. (*Acta radiol.*, Suppl. xxvi.) Von Erik Lysholm, Dozent für Medizin, Radiologie; Bertil Ebenius, Knut Lindblom, Hans Sahlstedt, Assistenten am Röntgeninstitut. Paper. Price, Swed. cr. 12. Pp. 124, with numerous illustrations. Stockholm: P. A. Norstedt & Söners Förlag, 1935.

Dr. Lysholm is the author of a three part work on the ventriculogram. Part III, here reviewed, is first published and may be had independent of the other two.

The third and fourth ventricles are visualized

both by air and opaque oil. The proportion of cases of air and oil visualization in this book is not the same as in the author's practice, a greater number of the latter being used because of the greater contrast and consequent better reproduction. In his clinic the use of oil is becoming less frequent as the technique and interpretation of air ventriculography are improved.

He has found the use of oil quite unnecessary in the study of the third ventricle, and necessary for the aqueduct and the fourth ventricle only in cases of high grade obstruction. Oil should be regarded only as an accessory to air injection in cases where it is necessary to outline a tumor not revealed by air and where the dangers of retained oil are offset by the necessities of the situation. If immediate operation is planned so that the oil may be removed at operation and the passageways cleared the procedure may be safely used.

The material on which the book is based consists of 134 cases, of which 58 are illustrated, and the history and roentgen findings before and with the contrast medium briefly given. The ventriculograms are excellent and aid is given in their interpretation by diagrams showing the location of the tumor or shadows of especial interest.

The book deals with the subject in eleven parts, each part representing an anatomical region, such as the anterior part of the third ventricle and foramen of Monro, the posterior part of the third ventricle, the aqueduct, the pons, the fourth ventricle, etc.

Inasmuch as neither the roentgenologist nor the surgeon interested in brain lesions can see too many of these instructive cases this book is worthy of careful study.

E. Walter Hall

Röntgenologische Beobachtungen über die Ossifikation der Patella. (*Acta radiol.*, Suppl. xxvii.) Von Hans Hellmer. Paper. Price, Swed. cr. 10. Pp. 82, with 211 illustrations. Stockholm: P. A. Norstedt & Söner, 1935.

This very interesting monograph is based on a study of over 500 normal children, some of whom were serially studied over a period of eight years, and in addition many cases of patellar injury and disease.

Some relatively little known facts about multiple and irregular centers of ossification are discussed. By observation of many such cases Dr. Hellmer is enabled to present differential diagnostic points between normal bones and those affected by disturbance in development disease, or injury. Separate chapters are devoted to Köhler's disease, Johansson-Sinding-Larsen's disease, patellar fractures and partite patella. These subjects are very important in medicolegal work, as disease and developmental anomalies have frequently been attributed to a particular trauma.

The author makes use of posteroanterior, lateral and axial views. It is evident from a study of his illustrations that the axial view adds much to the diagnosis and its use should be more general.

The numerous good illustrations as well as the subject matter should commend it to roentgenologists.

E. Walter Hall

Books Received

The 1935 Year Book of Radiology. Diagnosis, edited by Charles A. Waters, M.D., Associate in Roentgenology, Johns Hopkins University, Assistant Visiting Roentgenologist, Johns Hopkins Hospital, Associate Editor: Whitmer B. Firor, M.D., Assistant in Roentgenology, Johns Hopkins Hospital; Therapeutics, edited by Ira I. Kaplan, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York; Director, Radiation Therapy Department, Bellevue Hospital, New York City, etc. Cloth. Price, $4.50. Pp. 580, with 619 illustrations. Chicago: The Year Book Publishers, Inc., 1935.

Röntgenology: The Borderlands of the Normal and Early Pathological in the Skiagram. By Alban Köhler, Prof. Dr. med., Wiesbaden, Ex-President and Honorary Member of the German Röntgen Society; Life Member of the British Institute of Radiology and Röntgen Society, etc. Second English edition revised by the author. Translated and edited by Arthur Turnbull, M.A., B.Sc., M.B., Ch.B. (Glasg.), Ex-Demonstrator of Anatomy, University of Glasgow. Cloth. Price, $14.00. Pp. 681, with 400 illustrations. Baltimore: William Wood and Company, 1935.

Radium Treatment of Skin Diseases, New Growths, Diseases of the Eyes, and Tonsils. By Francis H. Williams. M.D. (Harv.), S.B. Massachusetts Institute of Technology; Senior Physician Boston City Hospital; Fellow American Academy of Arts and Sciences, etc. Cloth. Price, $2.00. Pp. 118, with 12 illustrations. Boston: The Stratford Company, 1935.

THE PRINCIPLES AND PRACTICE OF X-RAY THERAPY. By Ffrangcon Roberts, M.A., M.D. (Cantab.), M.R.C.P. (London), D.M.R.E. (Cantab.), Physician in charge of the Douty X-Ray Clinic, Addenbrooke's Hospital, Cambridge; Examiner in Radiology, Cambridge University. Cloth. Price, 10s. 6d. Pp. 214, with 115 illustrations. London: H. K. Lewis & Co., Ltd., 1936.

FOUNDATIONS OF SHORT WAVE THERAPY. Physics—Technics—Indications. Physics and Technics by Wolfgang Holzer, Dr. Ing.: Assistant in the Physiological Institute of the University of Vienna. Medical Applications by Eugen Weissenberg, Dr. Med.: Medical Superintendent of the Short Wave Section of the University Clinic for Nervous and Mental Diseases in Vienna. Translated by Justina Wilson, F.R.C.P. Edin., D.M.R.E. Cantab., and Charles M. Dowse, B.Sc. Eng. Lond., A.M.I.E.E. Cloth. Price, 12s.6d. Pp. 228, with 53 illustrations and 10 tables. London: Hutchinson's Scientific and Technical Publications, 1935.

CLASSICAL CONTRIBUTIONS TO OBSTETRICS AND GYNECOLOGY. By Herbert Thoms, M.D., Associate Professor of Obstetrics and Gynecology, Yale University. With a Foreword by Howard A. Kelly, Emeritus Professor of Gynecology, Johns Hopkins University. Cloth. Price, $4.00. Pp. 265, with 58 illustrations. Springfield, Illinois: Charles C Thomas, 1935.

FREE MEDICAL CARE (Debater's Help Book, Volume 11). Compiled and edited by E. C. Buehler, Director of Forensics, University of Kansas. Cloth. Price, $2.00. Pp. 360. New York City: Noble and Noble, Publishers, Inc., 1935.

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., M.S., 105 Rutledge Ave., Charleston, S. C.

A PRACTICAL DEVICE FOR GASTROINTESTINAL ROENTGENOGRAPHY UNDER ROENTGENOSCOPIC CONTROL

By WILLIAM R. STECHER, M. D.
PHILADELPHIA PENNSYLVANIA

IN THE routine gastrointestinal examination some roentgenologists are apparently satisfied with the production of a short series of films, usually made without roentgenoscopic control. This can be ascribed to the fact that it is economically prohibitive for the small radiological laboratory to purchase complicated expensive apparatus of limited use. In addition, much of the current apparatus is unwieldy and impractical, as it either does not permit of roentgenoscopic control in the erect position, or it requires many special size cassettes, etc. If 8″×10″ cassettes are employed, as is the common practice, the cost of a thorough examination becomes

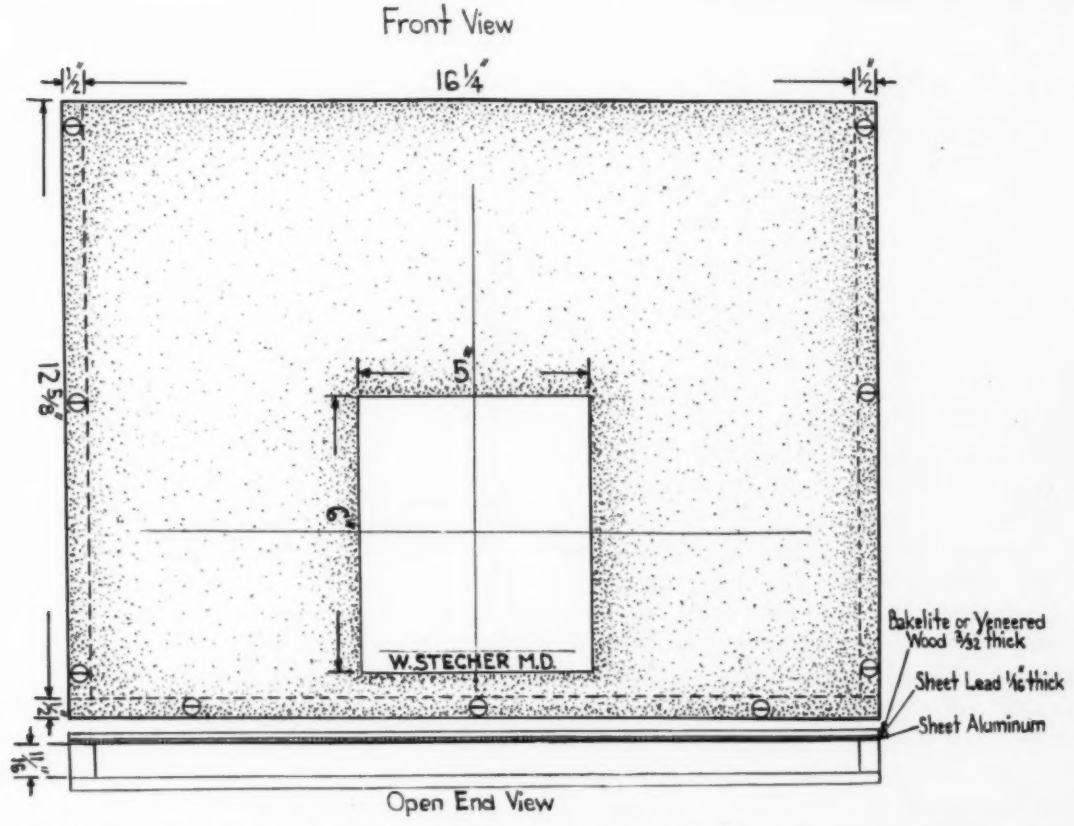

FIG. 1*a*. Front view of device. Note that name plate is imbedded between bakelite front and aluminum sheet behind. Cross lines scribed upon bakelite aid in localization. Upper border of 10″×12″ cassette projects 5/8″ and permits of manual transference and shifting of cassette.

well nigh prohibitive for many. With these considerations in mind, the following described device was designed.

The device, as illustrated in Figure 1, is for the greater part self-explanatory. The wire frame graphically shown in Figure 1 maintains the device in position against the roentgenoscopic screen, and is constructed to conform to the individual size of the roentgenoscopic screen in such a manner as to permit of the exact centering of the diaphragmed beam of radiation upon the area of the device which is unshielded. This wire frame attachment can be removed, thus permitting the device to be utilized for other procedures to be described. All elaborate accessories have been purposely omitted to minimize the weight of the apparatus, which allows free shifting of the roentgenoscopic screen.

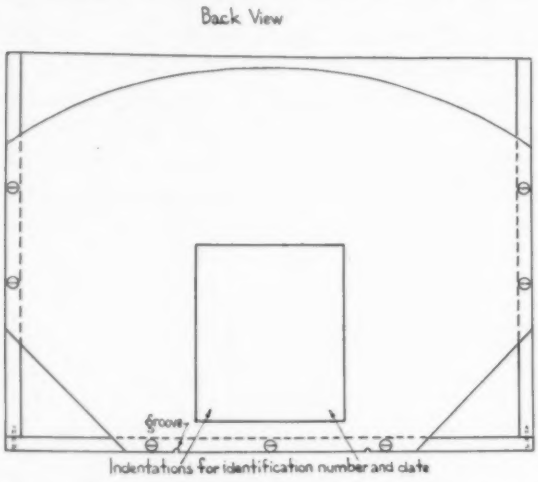

Fig. 1*b*. Back view of device. Lower border of apparatus is grooved to accommodate lower cross pieces of the hanging wire contrivance, and prevents sideward motion when positioned.

It is imperative that all exposures of the duodenum and antrum be made at the most favorable time and in the optimum position; which can only be positively determined by roentgenoscopy. In the demonstration of a duodenal ulcer, it is of paramount importance to make the roentgenographic exposures during the active period of the stomach, i.e., when the barium mixture completely fills the duodenal cap. It is necessary, therefore, for the roentgenologist to be able to change rapidly from roentgenoscopy to roentgenography. The presence of a duodenal niche can sometimes only be demonstrated by tangential roentgenoscopy and roentgenography, by viewing the ulcer crater in profile. This is accomplished by rotating the patient into the optimum position for visualization of the niche, and simultaneously freeing the antrum and duodenal cap from the overlapping shadows of the second portion of the duodenum and antrum, respectively. The same difficulties are encountered in the demonstration of duodenal diverticula and partial obstruction of the lower duodenum, and many other specific examples can be cited which conclusively demonstrate the importance of roentgenoscopically controlled roentgenography in the examination of the gastrointestinal tract.

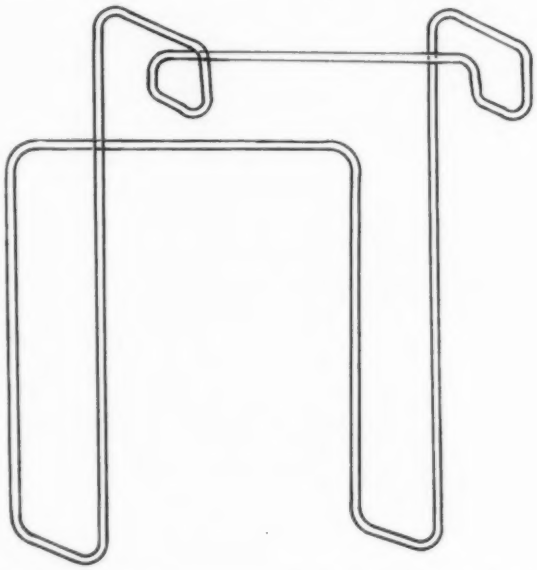

Fig. 1*c*. Wire contrivance to support device upon the roentgenoscopic screen.

The technique evolved by Åkerlund and Berg is now the standard method accepted by the German school, and briefly consists in obtaining mucosal patterns in relief, of localized portions of the gastrointestinal tract, made with the aid of graded compression under roentgenoscopic control.

The patient ingests one ounce of a thin

watery barium mixture, and after preliminary roentgenoscopic examination of the mucosal pattern of the esophagus and stomach with the patient in the erect position, the apparatus is adjusted upon the roentgenoscopic screen as shown in Figure 2. A large aluminum spoon is employed as a means for producing compression of the duodenal cap, and this region is carefully examined for its mucosal pattern. After determining the optimum position, exposures are made of the region with graded compression, in order to obtain the correct degree of expression of the superfluous barium mixture from the region.

This procedure is best accomplished with the aid of an assistant, who rapidly resets the auto-control back and forth from roentgenoscopy to roentgenography, and makes the desired exposures while the roentgenologist maintains and varies the degree of compression for each exposure. However, if a mechanical Chaoul compressor is employed, the operator can readily carry out the entire technique himself. A dim ruby light which illuminates the control stand is an invaluable adjunct in facilitating rapid resetting of exposure factors.

Thus, four exposures are made upon the respective corners of the film by shifting the 10″×12″ cassette from one corner to the other, inverting and shifting the cassette for the remaining two exposures. During each successive period of roentgenoscopy the cassette is removed and placed at a conveniently safe distance from the beam of radiation, preferably behind

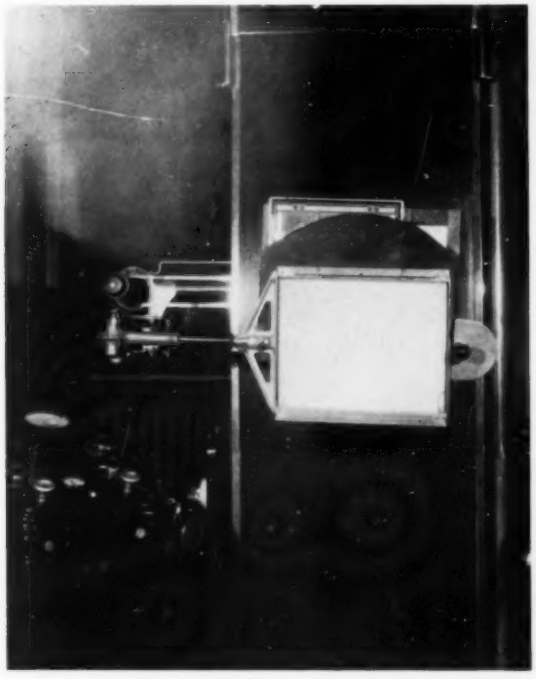

Fig. 2. Showing device centered upon the roentgenoscopic screen, with cassette in position for an exposure. The auto-control stand with overhanging ruby light is nearby to facilitate rapid shifting from roentgenoscopy to roentgenography. Also, observe timer on side of control stand. Note that the device is exactly centered, by means of the wire hangers so that the unshielded area is in the center of the diaphragmed roentgenoscopic field. Also, note that upper edge of cassette overlaps to aid in shifting the cassette. Total weight of apparatus is less than 3 pounds.

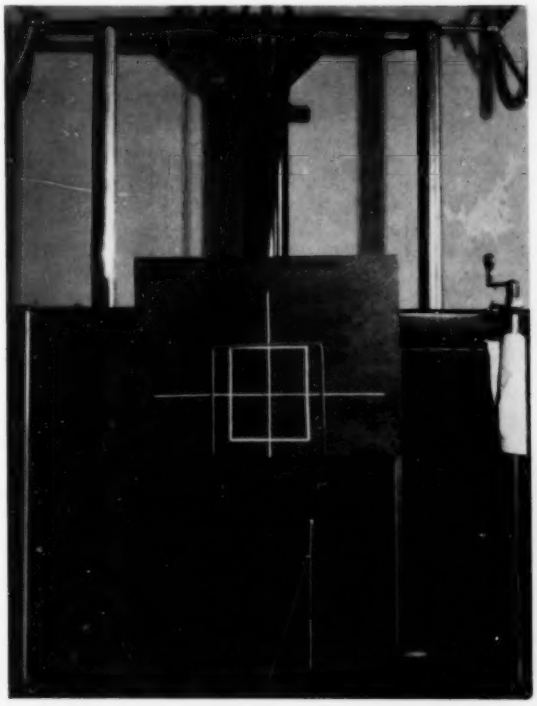

Fig. 3. Showing how the device can be utilized for vertical paranasal sinus examination by attaching upon a standard adjustable cassette changer. The patient is seated in front of apparatus, positioned and immobilized with the aid of the compression band.

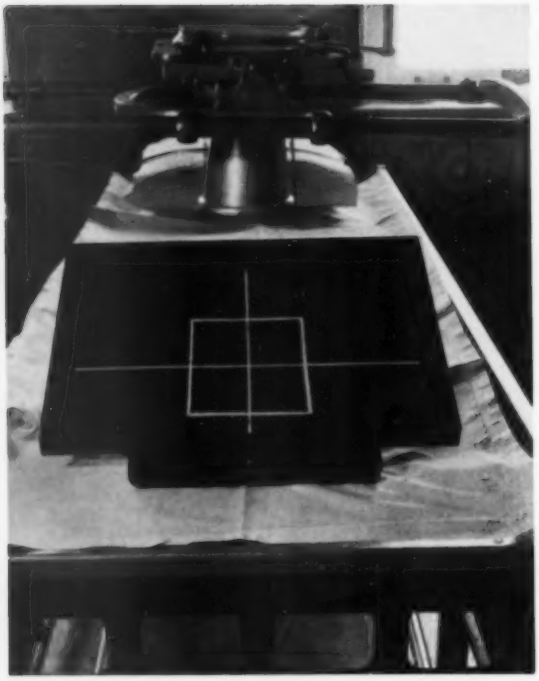

FIG. 4. For routine paranasal sinus or mastoid examination, the device is placed upon an inclined plane. The compression band attached to the Potter-Bucky diaphragm is utilized for immobilization. Patient is seated at one end of roentgenographic table and properly positioned.

the auto-control stand, to protect the film from undesirable scattered radiation.

Further films are then made, after the ingestion of a routine barium meal. The same technique is employed as outlined above, with the omission of compression. Since the advent of the line focus tube, which is capable of greatly increased energy output per effective focal spot size, the following exposure factors can unhesitatingly be produced: 100 or 50 ma., with the time factor of 0.2 and 0.5 second respectively, and with a variable penetration of 75 to 90 kv. (peak) at a focal-film distance averaging 28 inches (see Fig. 5).

Perhaps the greatest inducements for the adoption of this technique are the increased percentage of niche visualization and the infrequency of re-examinations. In addition, since the ulcer crater is more definitely outlined than with the customary technique the method offers itself as a valuable aid in determining the response of a peptic ulcer to medical treatment, by rechecking the pathologic anatomical contour at definite intervals. A word of warning is necessary, namely, that extreme accuracy of technique and interpretation is necessary, the latter being acquired only after considerable experience with the method, since the beginner tends to mistake slightly atypical mucosal relief patterns for niches, which are often artefacts the result of improper compression.

The new Lysholm grid is especially valuable for fractional second exposures, and for roentgenoscopy, inasmuch as the grid lines are practically invisible, and the grid can readily be placed in position in the space provided on the device which is unshielded. This renders the device more useful and it can be advantageously employed in the roentgenography of the paranasal accessory sinuses, there being sufficient film space upon a 10″×12″ film for four views of this region, by careful positioning and proper use of localizing cones. It is

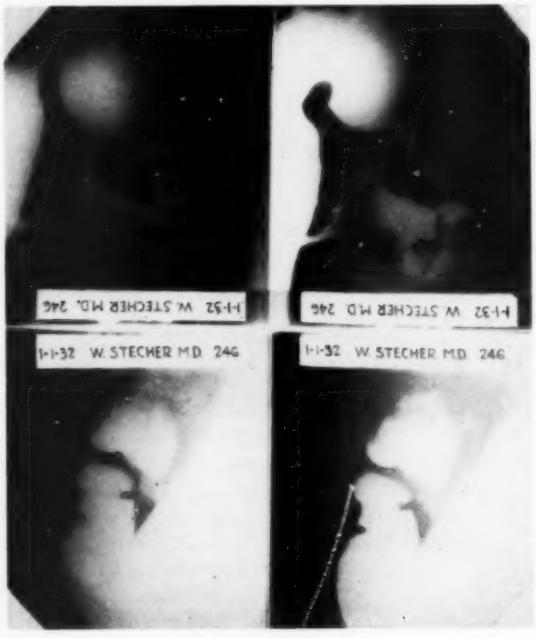

FIG. 5. Reproduction of film made with technique outlined, employing a routine barium meal and without compression. If desired, the film can be cut in half.

also applicable for the ordinary technique as shown in Figure 4 and in the erect position as shown in Figure 3. The latter is desirable in conjunction with lipiodol injections of the maxillary sinuses. Stereoscopic technique is permitted with this apparatus as has been outlined in detail in a previous communication.[1]

A similar device accommodating an 8″×10″ cassette is exceedingly valuable for visualization of the duodenal bulb.

I wish to express my sincere thanks for the kind consideration and cooperation, of Dr. T. P. Loughery, radiologist to the Germantown Hospital.

[1] Loughery, T. P., and Stecher, W. R. An improved stereoscopic mastoid examination. Am. J. Roentgenol. & Rad. Therapy, 1933, *29*, 112–115.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

SKELETAL SYSTEM

GELLMAN, MOSES. Arthrokatadysis of the hip joint. *South. M. J.*, 1934, *27*, 215–219.

The term is defined as a non-traumatic, atypical, chronic, progressive arthritis, characterized by a sinking in of the acetabulum and the intrapelvic protrusion of the femoral head. Three cases are presented as additions to the 89 reported since the discovery of the condition by Otto in 1824. Four distinct stages of the process have been recognized: (1) a localized destructive inflammation of the bony acetabulum; (2) an almost complete preservation of the head and neck of the femur in its longitudinal axis; (3) intrapelvic protrusion of the acetabular periosteum due to pressure from the femoral head, and (4) a rapid, smooth healing, resulting in a newly formed acetabular floor and a permanent dome-shaped intrapelvic protrusion. Etiologically, most observers feel that it is a clinical entity, not a disease, the end-result of an inflammatory or degenerative process within the hip joint. Pomeranz states that it may be produced by any disease resulting in localized osteomalacia of the acetabulum, the femoral head remaining intact. The destructive process must not be too severe and must permit bone regeneration.—*W. R. Brooksher.*

FELSENREICH, FRITZ. Die Röntgendiagnose der veralteten Kreuzbandläsion des Kniegelenks. (The roentgen diagnosis of old lesions of the crucial ligaments of the knee.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, *49*, 341–346.

In cases of recent injury to the crucial ligaments of the knee the roentgen findings are positive in about 13 per cent, whereas in old cases they show changes in 53–62 per cent due to changes in the points of insertion of the igaments which do not show up within six months of the injury and which are most apparent one to two years after it. These changes are present at the insertion of the anterior ligament in the tibia, commonly at the medial spine and less commonly at the lateral spine. The roentgenogram usually shows a small hollow between the spines. In old injuries the femur shows a small elevation near the lateral spine which is pointed. An anteroposterior film with the leg at 160° extension is necessary to demonstrate this. The author next describes the particular changes encountered. The examination is especially valuable when films can be taken at intervals for a long time after the injury.—*E. T. Leddy.*

VISCHIA, QUINTINO. Il morbo di Osgood-Schlatter in rapporto alla patogenesi. (The pathogenesis of Osgood-Schlatter's disease.) *Arch. di radiol.*, 1934, *10*, 415–420.

Osgood-Schlatter's disease generally occurs in young people from ten to sixteen years of age; sometimes there is a history of trauma but sometimes it begins slowly and gradually with vague pain in the tuberosity of one or both tibias which increases until active and passive movements are limited. There are many theories in regard to its pathogenesis. Osgood and Schlatter themselves attributed it to avulsion of the anterior tuberosity of the tibia. Some authors consider it inflammatory in nature and it has been attributed to tuberculosis and syphilis.

The author describes 2 cases, one in a boy of twelve and one in a boy of fourteen, both following trauma, which he is inclined to think is an important factor in pathogenesis. In the roentgenograms of both cases the anterior tuberosity of the tibia appeared to be detached from the diaphysis. It had the form of a bird's beak turned downward.—*Audrey G. Morgan.*

BERENT, FRITZ. Zur Ätiologie der Ostitis condensans ilei. (The etiology of osteitis condensans ilei.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1934, *49*, 263–266.

Condensing osteitis of the ilium in women is usually a healed stage of periosteal ligamentary and capsular damages taking place in pregnancy. A comparison with late changes following true pelvic injury gives complete agreement in roentgenologic findings. In the diagnosis of osteitis condensans ilei it is necessary to exclude arthrotic changes.—*E. T. Leddy.*

HATZKY, KURT, and MÜLLER, KONRAD. Über lokalisierte herdförmige Knochenatrophie bei hypophysär-ovariellen Störungen. (Localized focal bone atrophy in hypophyseal and

ovarian disturbances.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1934, *49*, 117–127.

The authors report 2 cases of flake-like bone atrophy of the lower tibia and bones of the foot. In both cases there were symptoms of ovarian and pituitary dysfunction. Both cases were greatly improved by calcium-vigantol. These cases differed clinically and roentgenologically from the usual appearances found in endocrine disturbances. They resembled Leriche's disease of bone and the acute atrophy of bone described by Sudeck.—*E. T. Leddy.*

Goldhamer, Karl. Osteodystrophia fibrosa unilateralis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1934, *49*, 456–480.

This is the report of a case of osteodystrophia fibrosa proved microscopically and observed for four and one-half years, occurring in a girl of nine, which showed the following peculiarities. (1) Localization of the diffuse fibrotic bone changes in the left arm and left leg and the left ischium. In the left hand and anterior portion of the left foot the bone changes extended lateral-mesially and proximo-distally (that is, opposite the epiphysis). (2) Circumscribed fibrous changes in the left side of the skull, diffuse fibrous changes in the left lower jaw, fibrous changes in the left occipital region. (3) Cystic changes in the left ilium, pubis, the left femur and marked involvement of the left tibia and fibula. (4) Osteosclerotic changes in the left half of the base of the skull and left facial region. (5) Marked unilaterality (a fibrotic process did involve the occiput to a slight extent). (6) Combination with precocious puberty. The paper is profusely illustrated and has an extensive bibliography.—*E. T. Leddy.*

Rummert, O. Ostitis deformans Paget und Diabetes insipidus. (Osteitis deformans and diabetes insipidus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 85–90.

This is the first case of osteitis deformans (Paget's disease) reported which was favorably affected by pituitary preparations. Osteitis deformans is therefore the result of a disturbance of hypophyseal function. Long continued use of hypophyseal extract is the best method of treatment of the lesion.—*E. T. Leddy.*

Staunig, Konrad. Über Periarthritis humeroradialis. (Periarthritis humeroradialis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 90–92.

The author reports a case in which the elbow was red and swollen over the humeroradial articulation. There was some effusion and much pain. Roentgen examination showed a layer of calcium in the joint capsule of the humeroradial joint. These findings correspond to that seen in periarthritis humeroscapularis, both clinically and roentgenologically. The author thinks the cause is traction on the joint capsule. As the result of trauma there follows colloidal coagulation with adsorption of calcium which makes the condition visible roentgenologically. —*E. T. Leddy.*

Sternberg, H. Über Röntgenbefunde bei Osteomyelitis der Wirbelsäule und Spondylitis infectiosa. (The roentgen findings in osteomyelitis and infective spondylitis of the spine.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 32–56.

From reports in the literature and many personal observations Sternberg reviews the roentgen appearance of non-tuberculous inflammatory lesions of the spine. He discusses in considerable detail two conditions which have been investigated infrequently—subacute benign vertebral osteomyelitis and chronic infectious spondylitis. He attempts to correlate the roentgen and post-mortem findings in various types of lesions of the vertebral column and illustrates some typical cases. The differential diagnosis is discussed extensively, particularly with reference to tuberculous spondylitis.—*E. T. Leddy.*

Hellner, Hans. Fistelkarzinome auf dem Boden chronischer Osteomyelitis. (Carcinomatous fistula on the basis of chronic osteomyelitis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1934, *49*, 109–117.

Carcinomatous fistula starting on a chronic osteomyelitis of bone or joint tuberculosis is uncommon in comparison with the frequency of these conditions. The author describes 3 such cases which started after ten years of fistulous discharge. Clinical observation and repeated roentgen examinations permitted the determination of the onset and the proof of the carcinomatous fistula. For the first time serial roentgenograms of this condition are published. To make the diagnosis definite biopsy should be made as early as possible. In one case roentgen treatment may have been a contributing cause. The best treatment is early amputation. —*E. T. Leddy.*

PRICE, ALVIN E., and SCHOENFELD, JOHN B. Felty's syndrome; report of a case with complete postmortem findings. *Ann. Int. Med.*, April, 1934, *7*, 1230–1239.

A seventh case of Felty's syndrome is reported in detail with complete necropsy findings. The symptom-complex is characterized by three important clinical features: splenomegaly, leukopenia and arthritis. It is best explained as a single pathologic process, the result of a chronic infectious lesion. In the present case, roentgen study of the wrists and hands showed moderate soft tissue swelling about some of the phalangeal joints without bone absorption or destruction of cartilage. There was a slight tendency to overgrowth of the articular margins of some of the phalangeal joints, with slight hypertrophy of the cortical portion of one of the metacarpals.—*W. R. Brooksher.*

HAMMARSTRÖM, S. Ein Fall von Chondroblastischem Sarkom. (A case of chondroblastic sarcoma.) *Acta radiol.*, 1934, *15*, 668–676.

The author describes a case of chondroblastic sarcoma in a boy of seventeen who was treated for a month and a half with the diagnosis of synovitis of the right knee. He had slight swelling, pain on pressure and pain on walking for a month before admission to the hospital. Two and a half months after the beginning of symptoms the patient was admitted to the hospital for the third time with similar symptoms and after exploratory excision a diagnosis of sarcoma was made and amputation performed. Microscopic examination showed chondroblastic sarcoma. Uneventful recovery; patient complains of slight pain in the amputation stump.

Only 27 cases of this form of sarcoma have been published before, all of them in the American literature. They generally occur in young people less than twenty-four years of age. This indicates that they are associated with a special stage in bone development and this theory is strengthened by the fact that they always occur in the epiphyses, particularly the epiphyses of the long bones where bone proliferation is most active. They resemble Ewing's sarcoma but in the latter disease there is bone formation and more diffuse infiltration of the diaphysis. The macroscopic appearance of chondroblastic sarcoma is that of an organized hemorrhage—a dark red, jelly-like mass containing scattered bits of necrotic bone. Sometimes they are firmer with grayish or bluish-white parts that resemble hyaline cartilage. Microscopic examination shows the tumor cells strikingly like those seen when the blastema in the embryonic skeleton is being differentiated into cartilage cells; there are also cartilage cells of varying ages without pronounced differentiation. There are no traces of myxoma tissue or the so-called precartilaginous connective tissue. Unlike osteoid sarcomas these tumors never produce bone. There are many giant cells in the peripheral parts of these tumors.

The prognosis is bad. Among Copeland and Geschickter's 24 cases only 2 have survived for more than five years. The best treatment is amputation with intensive preoperative and postoperative radiotherapy.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

CHODKEWITSCH, S., and LASKAREW, A. Über die klinische Bedeutung der Venographie bei Venenerweiterung der Unterextremitäten. (The clinical importance of venography in cases of varicose veins of the leg.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1934, *49*, 143–147.

The authors describe in detail the technique of the method they employ for the roentgenologic visualization of veins by sodium iodide solution. By means of it they differentiate between localized and diffuse types of dilatation and thereby obtain information as to whether an operative or conservative method of treatment should be adopted, and by it the results of treatment may be evaluated. Strong solutions are useful in sclerosing the vessels. They have used the method in 17 cases. Typical roentgenograms are given and some of the peculiarities of the anastomoses in the leg are discussed.—*E. T. Leddy.*

HORTON, BAYARD T. Arteriovenous fistula involving the common femoral artery identified by arteriography. *Am. J. M. Sc.*, May, 1934, *187*, 649–652.

The author presents a case report with roentgen films demonstrating the definite localization of an arteriovenous aneurysm of the right femoral artery.

The patient was a young male who had sustained a bird shot wound of both thighs. Twenty-four days after the injury a definite

bruit was heard over the right femoral artery. The oxygen saturation of the blood taken from the right femoral artery and vein was considerably higher than in the blood taken from the corresponding vessels of the opposite thigh. The blood pressure in the right thigh was 140 systolic and 100 diastolic, as compared with 120 systolic and 100 diastolic on the left side. From these findings a clinical diagnosis of arteriovenous aneurysm was made.

The right femoral artery was occluded by digital pressure and 25 c.c. of thorotrast injected distal to the point of pressure. Several films were then made in rapid succession. In the film demonstrated the author shows the femoral artery and vein outlined well by the opaque solution. The vein shows several localized dilatations probably due to back pressure in regions of the valves. No mention is made of subsequent roentgen examinations to determine the ultimate disposition of the thorium dioxide in the body, although the patient evidently showed no toxic effects.—*G. W. Chamberlin.*

Kruchen, C. Jodipin in den Lymphwegen nach Myelographie. (Iodipin in the lymph vessels after myelography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, *49*, 155–157.

In a patient who had had myelography with iodipin the contrast medium could be demonstrated six months later in the perineural lymph channels of the lower cord. There was no extension along the cauda equina. The shape of the shadow and the method of migration of the opaque medium allowed it to be assumed that the lower lumbar sac had an active function.—*E. T. Leddy.*

ROENTGEN AND RADIUM THERAPY

Buisson, Paolo. Sul problema terapeutico dei tumori maligni. (The problem of treatment of malignant tumors.) *Arch. di radiol.*, 1934, *10*, 354–363.

The author holds that all attempts at treatment of malignant tumors by surgery or local methods of roentgen and radium irradiation have failed and will necessarily always fail because cancer is never at any stage a local disease. It is a general disease from the first and must be treated by general measures. It is analogous in this respect with syphilis and tuberculosis. No one assumes that when the primary syphilitic lesion appears the disease is localized there and can be cured by excision of the lesion. It is known to be generalized at that time and is treated accordingly. The same is true of the visible appearance of cancer. The local lesion is only a manifestation of a general disease.

No form of surgery can ever be anything more than a local treatment but there are forms of irradiation that constitute a general treatment. Radium and radioactive preparations may be used for general treatment in the form of emanations and injections of soluble radioactive substances but much more work must be done by collaboration between physicians, chemists and physicists before these methods can be considered successful. The methods of panirradiation, telepanirradiation and supertelepanirradiation proposed by Palmieri and Heublein are methods of general radiotherapy and worthy of further experimentation in the treatment of malignant tumors.—*Audrey G. Morgan.*

Jona, Eugenia. Morbo di Flajani Basedow and roentgen therapy. (Roentgen treatment of Flajani-Basedow's disease.) *Arch. di radiol.*, 1934, *10*, 377–414.

Nine cases of Basedow's disease treated by roentgen therapy are described in detail. They were not all typical Basedow cases; some of them had associated disturbances of other origin.

The treatment consisted of a preliminary irradiation of a thymo-thyroid field with 10 per cent of an erythema dose with a filter of 4 mm. aluminum. After an interval of four days three fields, one anterior and two lateral were irradiated with 20–25 per cent of an erythema dose with an interval of four days between each two irradiations. After a month the same cycle was repeated and after that as many times as necessary, always with an interval of a month between cycles.

The results are reported with reference to the different symptoms separately. Most of the patients lost weight at first but after a month the weight had returned to its beginning value or in most cases risen above it. In cases in which there had been a high glycemia it was greatly lowered; where it had been near normal there was only a slight lowering. In cases in which there was a positive alimentary glycosuria it became negative. The leukocyte formula returned to normal. The subjective symptoms improved and the reaction to adrenalin re-

turned to normal. The elimination of creatinin increased as the symptoms improved.

The small number of cases does not permit of definite conclusions, but on the whole the results were satisfactory. Irradiation should be associated with medical treatment and rest.—*Audrey G. Morgan.*

ENGELSTAD, ROLF BULL. Über die Wirkungen der Röntgenstrahlen auf Ösophagus und Trachea. (The effect of roentgen irradiation on the esophagus and trachea.) *Acta radiol.*, 1934, *15*, 608–614.

Serious injuries of the esophagus and trachea from roentgen irradiation seem to be quite rare. Cases of injury have been described however. The author studied the question experimentally, using the following qualities of rays: 65 kv., 6 ma., no filtration; 65 kv., 6 ma., 1 mm. aluminum; 110 kv., 6 ma., 1 mm. aluminum; 175 kv. and 4 ma. without filtration and with 1 mm. aluminum, 0.5, 1, 2 and 7 mm. copper. He divides the dosage into 3 groups: subepidermicidal doses up to 1,700 r caused only a slight skin reaction. Epidermicidal doses from 2,200 to 6,830 r, depending on the conditions of irradiation, caused a pronounced roentgen epidermitis which however healed in four to six weeks leaving a smooth scar. Dangerous or lethal doses from 9,000 to 13,500 r caused death in a comparatively short time or severe epidermitis which when it healed left contraction and atrophy. Of course there were all degrees of transition between these different groups.

The irradiation caused degenerative and inflammatory changes in the esophagus and trachea which were clearly evident within from one to three weeks after the irradiation. After subepidermicidal doses the reaction was generally slight and subsided after two or three months; after epidermicidal and lethal doses the changes were very pronounced and in many cases had not subsided entirely after five or six months. In some cases the mucosa peeled off entirely and intense inflammation set in. The changes began earlier and developed more acutely in the esophagus than in the trachea. The mucosa of the esophagus is beyond doubt more sensitive to irradiation than that of the trachea but the difference is certainly not as great as was formerly believed and is shown chiefly by the different rapidity with which the reaction develops. A roentgen dose that causes distinct changes in the mucosa of the esophagus also causes distinct changes in that of the trachea.—*Audrey G. Morgan.*

KEITH, D. Y. Treatment of leukemia. *South. M. J.*, April, 1934, *27*, 318–323.

The treatment of leukemia is discussed, the author observing that a longer interval of apparent good health occurs where treatment was applied to the osseous system. Recently the roentgen-ray voltage has been varied in the author's cases according to the density of the bone under treatment. A study of 27 treated cases indicates that a more constant, prompt response is noted where higher voltages are used, and that the interval between treatments is much longer. Treatment with high voltage is logical since a more penetrating ray will penetrate the cortex to reach the medulla. —*W. R. Brooksher.*

BERTOLOTTO, UGO. La Röntgenterapia nelle forme inflammatorie ginecologiche. (Roentgen therapy of gynecological inflammations.) *Radiol. med.*, Oct., 1934, *21*, 1103–1126.

The author gives brief histories of 53 cases of various forms of gynecological inflammation treated by roentgen therapy. He used a Koch and Sterzel super-universal apparatus with 4 valves. The focus-skin distance was 30 cm. Filter 0.5 mm. copper and 3 mm. aluminum. The tension varied from 120 to 180 kv., 150 kv. being used in the majority of cases. Fields in the lower quadrants of the abdomen varying from 150 to 400 sq. cm. The half-value layer was 0.6 mm. copper up to 120 kv., 0.65 from that to 150 kv. and 0.9 to 180 kv. Hammer's dosimeter was used. The doses were small; doses of 50 r or less repeated 3 times in twelve days were used in the cases of acute inflammation with circumscribed exudate while doses of 75 to 100 r repeated 2 to 3 times were used in cases of pelviperitonitis and parametritis with extensive exudate. Doses of as low as 20 r were used with excellent results in a number of cases.

Excellent results were obtained in 37 per cent of the cases: rapid and complete absorption of the exudate and complete disappearance of all subjective symptoms; the total rises to 74 per cent if the good results are included, that is, marked improvement in general condition, and abolition of pain, while there was marked decrease but not total disappearance of the exudate. The best results were obtained in the cases of acute puerperal infection. This is contrary to the experience reported by some

authors who advise against using the rays in acute febrile cases. The author did not find the results any poorer in gonorrheal cases, as some authors have reported. There were only 2 cases in which the inflammation was aggravated. One special advantage of the treatment is the rapid and complete control of pain which makes it possible to institute local treatment. Several days are gained in this way. One case is mentioned in which irradiation brought about such marked improvement in the general condition and reduction of the exudate that a cyst could be diagnosed and operated on successfully.

Comparing the results obtained with those obtained by medical treatment alone, the time required for cure is considerably less in the irradiated cases. The roentgen treatment was associated with medical treatment and rest which were also factors in the cure.

The treatment is particularly indicated in septic puerperal processes. In these and the acute forms of inflammation of the adnexa it should be given as early as possible. It is less effective in chronic cases. Some authors recommend temporary castration in these cases. In pelviperitonitis with extensive exudate the results are not so good and some caution is necessary in these cases, particularly if the patients are in very poor general condition. The results were not good in cases of endometritis and cervicitis. Probably the intrauterine sepsis keeps up the inflammation in these cases. Pregnancy is not a contraindication and the author does not believe that there is any definite proof that the children are injured. —*Audrey G. Mörgan.*

Keene, Floyd E., and Payne, Franklin L. Functional uterine bleeding. *South. M. J.*, Feb., 1934, *27*, 108–113.

A statistical analysis of 500 cases of functional uterine bleeding is presented. In no case was there demonstrable pelvic disease or evidence of causative constitutional disease. The diagnosis was made in all cases after examination under anesthesia and a microscopic study of curettings. Endometrial hyperplasia was found in but 12 per cent of the menorrhagia group and 30 per cent of the metrorrhagias. Diagnosis and treatment are fully discussed. The statements of authorities as to the value of prolan therapy in young women and its futility after the age of forty are confirmed. After forty years and when other methods have proved unsuccessful in younger women, irradiation, preferably by radium, is indicated. Radium is rarely indicated under twenty years of age, and then the initial dose should not exceed 200 mg-hr. Between twenty and thirty years, 400 mg-hr. will be more than 80 per cent efficient in control of bleeding. In the group between thirty and forty, a dosage of 800–1,200 mg-hr. produced permanent amenorrhea in 56 per cent, and severe menopausal symptoms in 47 per cent of the patients. The administration of a menopausal dose in the age group forty to fifty is not desirable because of the high incidence of severe menopausal symptoms. The authors suggest an initial dose of 400 mg-hr. to this group. Should this and a re-irradiation dose of 500 mg-hr. fail, hysterectomy is advised. At the ages near fifty, increased dosage may be employed, and between fifty and sixty years, severe menopausal symptoms rarely follow the maximum dose.—*W. R. Brooksher.*

Waters, Charles A., Lewis, Lloyd G., and Frontz, William A. Radiation therapy of renal cortical neoplasms, with special reference to preoperative irradiation. *South. M. J.*, April, 1934, *27*, 290–299.

Renal tumors of the hypernephroma type and embryonal carcinomata are radiosensitive, while papillary carcinomata of the renal pelvis and the malignant papillary cyst adenomata are radioresistant. A remarkable reduction in size of radiosensitive tumors follows irradiation, often rendering operable those tumors which were previously inoperable because of size. There may be practically complete destruction of the tumor with replacement by fibrous tissue. Operation has not been made more difficult because of previous irradiation. The optimum time for nephrectomy is three weeks following irradiation and surgery should be performed with care to avoid metastasis. Technical factors employed are: 200 kv., 0.5 mm. copper, 2 mm. aluminum filters, 4 ma., at 50 cm. focal skin distance, the daily dose ranging from 195 to 345 r, depending upon the reaction. The saturation curves of Weatherwax have been employed to estimate the loss of radiation effect in the tissues. Detailed case reports are presented.—*W. R. Brooksher.*

Stirling, W. Calhoun. Treatment of prostatic cancer. *South. M. J.*, July, 1934, *27*, 590–597.

The author summarizes the opinions of 60 urological surgeons on the treatment of pro-

static cancer. With limitation of the growth to the capsule and with urinary obstruction present, prostatectomy with radium implantation and roentgen irradiation to the prostatic region is the method of choice. In the absence of obstruction, irradiation by radium and roentgen ray alone may be employed. With extension of the growth beyond the capsule, transurethral resection, repeated as needed, keeps the urethra patent, stops the pain and bleeding, and often retards the growth. All operative procedures should be preceded by a complete roentgen study to determine the size of the tumor, its location and extent, and if metastasis has occurred. The author presents 17 cases in summary form.—*W. R. Brooksher.*

TAYLOR, GRANTLEY W. Artificial menopause in carcinoma of the breast. *New England J. M.*, Dec. 20, 1934, *211*, 1138–1140.

The inter-relationship of breast abnormalities and ovarian hormonal activity is discussed. General systemic factors appear to be more significant for carcinoma of the breast than local etiological factors. In the management of inoperable or recurrent carcinoma of the breast, radiation castration is a procedure which may be of definite benefit to the patient. Younger patients may be expected to respond more favorably. Such therapy may also inhibit or postpone the development of metastasis by its suspensory effect on ovarian activity. Operable carcinoma of the breast complicated by pregnancy should receive prompt abortion.—*W. R. Brooksher.*

PHILLIPS, R. F. The x-ray treatment of some uncommon tumors. *Brit. J. Radiol.*, Nov., 1934, *7*, 670–684.

Marked improvement in the general condition of the patient, together with reduction in size of the tumor and relief of local symptoms, occurred in 8 of 20 cases of bone sarcoma treated with roentgen radiation by the author. The factors employed were: intensive split-dose method, 200 kv., 8 ma., Thoraeus filter, 40–50 cm. focal skin distance, with dosages of 1500–3600 r within 12–28 days. The ninth case of sarcoma of the round ligament of the uterus is reported with the interesting change of a sarcoma into fibrous tissue by roentgen irradiation. Neurofibromatosis is discussed and 2 cases are presented.—*W. R. Brooksher.*

MISCELLANEOUS

KNOX, LEILA C. Trauma and malignant tumors. *Am. J. Surg.*, Oct., 1934, *26*, 66–73.

The author discusses the problem of trauma and its relation to malignancy, presenting the pathological viewpoint of the impossibility of production of tumor in the laboratory by trauma although malignancy is easily produced in these same animals by the action of chemicals, chronic inflammation due to irritants, and physical agents. The variance of clinical, pathological and legal opinion serves to confuse the problem. Full information is needed in the individual case before any opinion is pronounced. There is need for the collection of material before the importance of trauma can be positively ascertained. Knox believes that no valid evidence has yet been offered to change her opinion that no causal relationship has been established between a single trauma to healthy tissue and the appearance of a malignant neoplasm.—*W. R. Brooksher.*

DETERMANN, A. Über die Verwendung von partieller Filterung bei Röntgenaufnahmen, insbesondere Lungenaufnahmen. (The use of partial filtration in roentgen examination and in particular in roentgenography of the lungs.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1934, *49*, 170–175.

The author recommends the use of a copper filter 0.05–0.1 mm. thick to bring out those details in a roentgenogram of the lung which are lacking when the film is exposed according to the usual technique. He illustrates the difference in roentgenograms taken as usual and according to his filtration technique.—*E. T. Leddy.*

SPIEGLER, GOTTFRIED. Auf dem Wege zu einer Methodik der richtigen Betrachtung von Röntgenfilmen. (A method for the correct viewing of roentgen films.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 57–67.

The author first discusses the photophysical aspects of film. So-called overexposed films are not overexposed so that by suitable methods of copying the areas of intense blackening in the film—and the film as a whole—can be viewed with much greater distinctness. By suitable treatment those areas which have sharp gradations may show increased detail. Spiegler describes a viewbox which is built on a new principle. It combines the advantages of

greater illumination and of shutters. It increases markedly the diagnostic value of the darkest areas on the film. The viewbox therefore presents a new technique in viewing negatives in that they are illuminated by light which is controlled similarly to the roentgen ray in a screen examination.—*E. T. Leddy.*

Lindblom, Knut. Secondary screening by means of filtering. *Acta radiol.*, 1934, *15*, 620–627.

The author has made comparative examinations of secondary filters and other secondary diaphragms and finds that secondary filters are far inferior to grid diaphragms in secondary screening capacity but that they are of the same value as short distance screening in this respect. Both light and heavy metals make suitable secondary filters. In addition to their filtering effects the heavier metals have an intensifying effect which may be used to compensate for the loss of darkening. Secondary filters and thin grid diaphragms do not have any detrimental effect on sharpness of outline. Secondary filters and intensification by means of metal foils improve the results when roentgenograms are taken without intensifying screens.—*Audrey G. Morgan.*

Forssberg, Arne. Uber die Einwirkung der Röntgenbestrahlung auf die Entwicklung von Mesotaenium Caldariorum. (The effect of roentgen irradiation on the development of *Mesotaenium caldariorum*.) *Acta radiol.*, 1934, *15*, 603–607.

The author irradiated the alga, *Mesotaenium caldariorum*. He found that low doses, up to about 2,000 r caused no change in its normal appearance. With doses from 2,000 to 15,000 r there was a gradual delay in the interval of cell division and multinucleated giant cells developed of a type that have been seen in other objects examined. The average number of nuclei contained in these cells was six. With doses from 15,000 to 76,000 r, the largest used by the author, this increase in the size of the cells gradually decreased again. With very large doses it probably falls to the normal average values without symptoms.

The growth curve of the cells after irradiation was also determined; it was found to be normal in type with doses up to 15,000 r and with larger doses irregular.—*Audrey G. Morgan.*

Wilder, R. M., Higgins, G. M., and Sheard, Charles. The significance of the hypertrophy and hyperplasia of the parathyroid glands in rickets and osteomalacia. *Ann. Int. Med.*, March, 1934, *7*, 1059–1069.

Erdheim's theory of a correlation between the function of the parathyroid glands and rickets and the correlation between the demands for the parathyroid product and the availability of vitamin D are discussed. Experiments were conducted on chicks revealing that deprivation of vitamin D, insufficient in degree to cause rickets, produced hypertrophy and hyperplasia of the parathyroids, and further, that the parenteral administration of parathormone in such cases prevented the hypertrophy and hyperplasia. However, with extreme vitamin D deprivation, parathormone restricted, but did not prevent, the hypertrophy and hyperplasia. Such changes in the parathyroids in the presence of vitamin D deficiency were concluded to be the result of an acceleration of the functional activity of the glands. The parathormone in increased amounts so acts on the organism as to intensify the effects of the vitamin, an amount insufficient to prevent rickets thus becoming fortified to a degree that it does prevent rickets. The parathyroid glands exhibit a compensatory mechanism in the presence of relative deficiency of vitamin D acting to prevent rickets or osteomalacia. In extreme vitamin D deficiency, the mechanism is inadequate for the protection of the organism.—*W. R. Brooksher.*

Nieman, C., and Zeyss, W. Das direkte Messen der Röhrenscheitelspannung im Therapiebetrieb mit einem geerdeten Zeigerinstrument (Culmimeter). (The direct measurement of tube voltage in therapy machines by means of a grounded indicator (culmimeter).) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1934, *49*, 271–284.

By means of the "Tuto" equipment the current meter may be placed on a grounded control stand. Even more important than measurement of tube current is direct and continuous measurement of tube voltage on the control stand. This end has been attained for the first time in the culmimeter, which reads directly the equivalent spark gap across the terminals of the roentgen tube. From one of the resistances consisting of many elements and which is in parallel with the tube, a voltage is tapped off symmetrically to the grounded

middle point, smoothed off through a valve rectifier and then is measured on a static voltmeter on the control stand. In the first part of this paper the theory of high voltage measurement is discussed in detail. In the second part of the paper the constriction of the high tension resistance units is exactly described and an exact description is given of all the component parts of the high voltage meter, together with its installation in a therapy apparatus.—*E. T. Leddy.*

UNGELENK, ALFRED. Eine Drehanodenröhre mit Hochtemperatur-Strahlungskühlung. (A roentgen tube with rotating anode and high temperature radiative cooling.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1934, *49*, 162–170.

A roentgen tube with a rotating anode is described, the most important characteristic of which is its cooling by high temperature radiation. The load is delivered to a plate-shaped tungsten front of the anode and when a sufficiently high temperature of it has been reached cooling follows by radiation. The tube permits screen examinations almost without limit. In roentgenography with a four-valve machine it can take for 0.1 second a 5.5 greater load than an equal-sized stationary anode and with a six-valve machine an eight times greater load. Of special interest is the arrangement of the anode in the anodal hemisphere which allows a high speed of rotation. The tube is shock proof and roentgen-ray proof. In conclusion the efficiency of the tube in gastric examinations is discussed.—*E. T. Leddy.*

GROSSMANN, G. Die elektrischen Vorgänge in den Hochspannungskreisen von Röntgenapparaten. (The electrical train of events in the high tension circuits of roentgen apparatus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 1–31.

This paper is a continuation of the study previously reported in this journal and in it Crossmann considers valve rectifiers and condenser apparatus from the point of view of their voltage curves under different loads. The capacities at the terminals of the apparatus are a desirable addition only in constant potential machines with a voltage doubling circuit such as the Liebenow as they then supplement the main condensers feeding the roentgen tube. They are a disadvantage in the case of the non-protected half-wave machine because they increase the capacitive asymmetry of the system and also in the case of Villard circuit and in voltage tripling circuits, for two reasons: (1) they cause a voltage drop (the tube voltage is reduced at no load in the Villard circuit in the ratio $C:(C+C_x)$ in the voltage tripling circuits in the ratio $C+\frac{C_x}{3}:(C+C_x)$ wherein C is the capacity of one of the main condensers and C_x is the terminal capacity; (2) they add a capacity component to the primary transformer current. The roentgen tube takes reversed voltage only in a half-wave valve machine. The peak value of the reversed valve voltage is equal to the peak power voltage of the roentgen tube in most hookups except the half-wave valve machines and those with voltage tripling circuit. In these two cases it is equal to about two-thirds of the power voltage of the roentgen tube. The duration of the reversed voltage at no load equals the period of the alternating current in most cases. In a six valve hookup it is practically equal to two-thirds of the current period. The load on the valve by reversed voltages at load is greatest in the half-wave valve machine and in the four valve rectifiers. The dielectric strain on the cables is relatively least in the Liebenow circuit and in six valve rectifiers; it is greatest in half-wave valve apparatus.—*E. T. Leddy.*

PETZOLDT, HERBERT. Ionometrische Messungen des Strahlenschutzes in medizinischen Röntgeninstituten. (Ionometric determinations of protection against radiation in medical roentgen departments.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1934, *49*, 406–415.

In the recommendations of the German Committee on Protection, a dose of 1.10^{-5} r/sec. is considered harmful to health. This value, called the Mutscheller unit, can only be determined by an ionometric method. The author used an instrument designed by Leistner to carry out systematic determinations of the intensity of roentgen rays in diagnostic and therapeutic installations and in this paper he gives the values so obtained.—*E. T. Leddy.*

DE WAARD, R. H. Der Nutzeffekt von Streustrahlenblenden. (The efficiency of scattered ray grids.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1934, *49*, 415–428.

The author describes some simple methods for testing the efficiency of scattered ray grids.

The selectivity is defined as the relative proportion of the radiation which penetrates the grid to the indirect radiation. Its importance is discussed and methods of calculating its value are illustrated.—*E. T. Leddy.*

Juris, K. Die Bedeutung des Schleiers für die Bildqualität. (The importance of fog in determining the quality of a film.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1934, *49*, 523–528.

Development should be continued until the greatest detail visibility is reached, which occurs with fresh developer in four or five minutes. Prolongation of development beyond this time increases development fog. A method is described which holds the action of developer constant. Losses of developer due to its being carried out of the tank by the wet film are made up by fresh developer from which potassium bromide is omitted, and this developer works in not more than six minutes. It should be filtered each week. Cloudiness does not seem to damage the films in any way. This system has been in use in the Zentralröntgeninstitut in Vienna for years. The importance of secondary radiation fog as it affects the most efficient viewing of detail in the films is discussed. When this fog is reduced as far as possible great improvement results. The suggestion of Herz and Luft that fog be used to observe detail in shadows at the cost of clearness is not recommended.—*E. T. Leddy.*

Thaller, Rudolf. Glühkathodenröhren mit selbsttätiger Durchgriffswahl. (Hot cathode tubes with self-regulating energy control.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1934, *49*, 528–533.

The author describes and illustrates a simple device for regulating the size of the focal spot in a roentgen tube so that with screening it is small and in roentgenography it is of the optimum size for the best definition with a given load.—*E. T. Leddy*

Allibone, T. E., and Bancroft, F. E. A new continuously evacuated x-ray tube for deep therapy. *Brit. J. Radiol.*, Feb., 1934, *7*, 65–82.

The evolutionary stages of roentgen tube development are briefly discussed, citing the deficiencies of the various designs. Even the modern sealed tube finds its limitations when subjected to higher kilovoltages of constant or almost constant potential. The explanation given is that the minimal quantities of residual gases are suddenly discharged, particularly from the anode terminal, because of the impact of very high voltage, and thereby the glass walls are punctured or the filament overtaxed. Because of this limitation it is the general practice to reduce the kilovoltage well below the rated capacity. This reduction very markedly decreases the output of radiation and therefore increases the time requirement. The authors have constructed a tube which, especially because of the feature of constant evacuation, has been found to tolerate voltages up to 380 kv. when the tube is left in air, or 500 kv. when in oil. The walls of this tube are of $\frac{1}{4}$ inch steel (except at the portal for radiation, where the thickness is reduced to 1 mm. steel). The anode is at ground potential and therefore running cold water obtained from the high pressure mains can be used to cool the target. The target is a disc of 1 mm. gold imbedded at a 30° angle in copper; the anode is steel and the filament itself is of tungsten. The emergent stream of radiation is positioned by vertical shifting of the whole apparatus or horizontal rotation of the target. The vacuum is readily obtained by an oil pumping device and the walls can be easily dissembled so as to make changes of the filament or target.—*A. A. de Lorimier.*

Müller, K. W. Das Problem der Röhrenspannungsmessung. (The problem of the measurement of voltage on the roentgen tube.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 66–86.

Methods of measuring voltage are of two types: (1) direct methods of tube voltage in which purely electrical quantities are measured; (2) indirect methods using some property of roentgen rays. These main groups may be subdivided: (*a*) direct measurement of tube voltage by its relation to primary voltage; (*b*) by the spark gap; (*c*) by high voltage resistors; (*d*) by the electrometer; (*e*) by the loading of a high voltage condenser; (2*a*) indirect methods of measuring tube voltage by limiting wave length; (*b*) by the half-value layer; (*c*) by a hardness scale. Exact determinations of voltage can be made only with such instruments as work free of error and free of surges. This statement holds for both diagnostic and therapeutic machines. The use of sphere gaps is discussed in detail. Standards are given for

resistances and the limits of voltage for spheres of various sizes, and the fact is pointed out that the distribution of voltage in a roentgen machine without grounding the high tension circuit is open to question.—*E. T. Leddy.*

GERMANN, HCH. Nomogramm zur Ermittelung von Heizspannungswerten für Glühkathoden-Röntgenröhren. (A nomogram for determining the heating voltage values for hot cathode roentgen tubes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 447–449.

The measured values of the emission currents of hot cathode roentgen tubes of varying type operated on various types of apparatus are directly related to the value of the applied voltage measured at the terminals of the heating transformer according to the formula: $Y = x^n \cdot 10$, in which Y = the emission current in ma., x a factor which is multiplied by the difference between the value of the heating voltage at 1 ma. and that at 10 ma. to determine the increase of voltage which is necessary to increase the emission current at 1 ma. to that at Y ma. n is the constant for the tube according to its construction which value is to be replaced in case of higher intensities by the following formula: $n' = n + (x/k)^2$, where k is a factor depending on the characteristics of the construction of the tube.

From these considerations the author has constructed a nomogram by which it is easy to determine the heating voltage necessary for any filament current greater than 1 ma. He shows how the value n and the divisor k are determined by the scale.—*E. T. Leddy.*

GROSSMANN, G. Die elektrischen Vorgänge in den Hochspannungskreisen von Röntgenapparaten. (The electrical phenomena of the high tension circuit of roentgen tubes. I.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 450–474.

Gossmann first explains how the high tension system of a roentgen machine is capacitively linked with its grounded parts. In machines with their high tension side insulated from ground these capacities made by the coils of the roentgen transformer and the heating transformer and their grounded parts are of the utmost importance. To these capacities there are added in the case of shock proof machines the even greater capacities of the cables. The half-wave machines are asymmetric with relation to capacity. Therefore the partition of voltage in them is asymmetrical. By calculation it is shown what effect these capacities and the insulation arrangement of the apparatus may have on the height and the phase of the voltage wave which the two high tension terminals of the roentgen transformer conduct to ground. As for half-wave machines with a valve it is shown how the potential difference between ground and the terminal of the apparatus separated from the roentgen transformer by the valve is influenced by the capacity of this terminal. This capacity builds up in the active half-wave whereby damped middle or high frequency oscillations are set up which are discharged through the roentgen tube. Finally, from diagrams of the voltage the duration of the tube voltage and that of the valve or discharge are demonstrated with different loads on the machine. The effects of these capacities on the phenomena in the primary circuit of the roentgen transformer are explained. The intensities of current are calculated which pass through a person's body on touching one of the high tension leads.—*E. T. Leddy.*

THALLER, R. Glühkathodenventile mit Lichtschleusen und Lichtfallen. (Hot cathode valves with a light trap and a light regulator.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 654–657.

The author describes two kinds of valves which eliminate light during roentgenoscopy common with ordinary valves. The light is stopped inside the tube and the electronic field is completely enclosed by the electrodes.—*E. T. Leddy.*

CHANTRAINE, H. Über die Unschärfe des Verstärkunsschirmes. (Lack of definition in intensifying screens.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 613–620.

The worth of an exposure is not determined by its sharpness or contrast but by its distinctness alone. The measure of distinctness is the size of the details that can be seen distinctly. Various causes add to each other to increase indistinctness, and among them the intensifying screen plays an important rôle. But to take serial exposures or many exposures of any sort without screens it is necessary to increase the load on the roentgen tube. The author feels that greater perfection of screens is needed to improve details in roentgenograms as in films of the lung taken without them detail is 30 per cent better.—*E. T. Leddy.*

Chantraine, H. Über ausreichende Belichtung ausreichende Entwicklung und ausreichend helle Betrachtungskästen. (Efficient illumination, efficient development and efficient viewing boxes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 340–346.

Experimentally it has been shown that underdevelopment of a film reduces recognition of detail, and for recognition of detail there must be a 30 per cent increase of density. With reduction, detail becomes recognizable with a 15 to 30 per cent increase of density. In the region of blackening 0.6 to 2.6 there was equally good recognition; below 0.6 the recognition of detail was reduced.

With greater blackening density it is possible to avoid the poor detail which is present with a blackening below 0.6. With much deeper blackening and density a 10 fold illumination in the view box is necessary.—*E. T. Leddy.*

Deutsch, Ladislaus. Über die Wirkung der Röntgenstrahlen auf die Katalase des Blutes. (The effect of roentgen rays on the catalase content of the blood.) *Strahlentherapie*, 1933, *48*, 114–117.

The catalase content of the blood was examined before and after therapeutic irradiation with roentgen rays. Only small doses, 20 to 30 per cent of a skin erythema dose, were given at each treatment. A radio-transverter apparatus was used with 180 kv. secondary, and 4 ma. The filters which were moderately hard varied in the different cases. Tables are given showing the details of the results. The catalase content of the blood increased under the action of roentgen rays. The increase was sometimes only relative, in proportion to the number of red blood corpuscles, but in most cases it was absolute. The degree of increase depended on the dose of radiation, on the site of the irradiation, and the size of the fields.—*Audrey G. Morgan.*

Menkes, Benedikt. Ein Röntgenverfahren zum Studium des Gesamtkreislaufs am lebenden Frosche. (A roentgenologic procedure for studying the total circulation of the living frog.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, *48*, 204–206.

Thorotrast introduced into the dorsal lymph sac of the frog gets into the circulation through the lymph heart and allows roentgen studies of the blood vessels to be made for a period of several days.—*E. T. Leddy.*

Demetrovic, B., and Alberti, W. Über den Einfluss der Fokusstruktur auf die Glanz- und Dunkelstreifen in Röntgenaufnahmen. (The effect of the structure of the focus on the light and dark streaks in roentgenograms.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 597–605.

This paper is as upplement to the authors' report in *Fortschritte*, vol. 47, page 718. It is known that dark and light striations on the same roentgenogram are not always comparable. In order to explain this fact the authors studied the intensities of radiation as influenced by the structure of the focus of the tube (differences of emission from different points in the focus) by dispersion; the unequal appearance of the striations is found due to variations in intensity which produce a Mach effect. This idea is confirmed by the fact that figures corresponding to the calculated curves of intensity can be produced by means of a rotating cylinder. The authors also show that the quality of a roentgenogram may be improved by changing these striations by a special roentgen tube upon which they will report shortly.—*E. T. Leddy.*

de Waard, R. H. Die Bedeutung der Selektivität von Streustrahlenblenden für die Kontraste im Röntgenbild. (The importance of selectivity of grids as regards contrast in the roentgenogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 606–612.

This paper is a supplement to a previously reported study of the author on the selectivity of grids. He here reports on a high selectivity rotating grid and shows its value in increasing the qualities of films under certain conditions. —*E. T. Leddy.*

Arendt, Julian. Tonungsversuche an Röntgenfilmen. (Some experiments on toning roentgen films.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 612–615.

The possible advantages of tinted films in bringing out detail in underexposed films, in giving greater illumination when films are projected in auditoriums and in intensifying diapositives after toning the negative are pointed out. Arendt thinks from his experiments that a bluish-green color is the best for these purposes and outlines the technique of dyeing the films. The method has to be considerably modified to work on paper negatives.—*E. T. Leddy.*

FRANKE, H. Wirkliches und Scheinbares im Röntgenbilde. (The real and the apparent in the roentgenogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1934, *50*, 53–71.

In this very interesting paper Franke points out many of the ways one may be deceived by a roentgenogram even though he may have expert knowledge of roentgen interpretation. He gives many examples of these deceptions—such as, for example, that of an apparent fracture, errors in localization of foreign bodies even by stereoscopy, pseudopathologic conditions in the lungs, errors due to superposition of shadows, and false evidence obtainable by the erroneous application of special techniques. The paper emphasizes that roentgen interpretation is the task for a specialist only—*E. T. Leddy*.

JURIS, K. Die Prüfung aufeinanderfolgender Röntgenfilm-Emulsionen gleicher Herkunft auf Konstanz ihrer wichtigsten Eigenschaften. (The testing of serial roentgen film emulsions of the same manufacture in regard to the constancy of their most important properties.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1934, *50*, 94–99.

Juris used the method of Kohaut and Spiegler to test the constancy of film emulsions. In this method the blue glow of the intensifying screen is replaced by light from a mercury vapor arc. He reports his examination of sample of twelve series of emulsions and concludes that the method is applicable in tests in medical roentgenology.—*E. T. Leddy*.

SCHOCKEN, KLAUS. Kontrastmessungen an Röntgenfilmen. (Measurement of contrast in roentgen films.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1934, *50*, 299–305.

The minimum contrast which can be perceived is 0.013 and is due to differences in intensity of light of 3 per cent. To produce roentgenograms as rich in contrast as is possible very soft roentgen rays and a Potter-Bucky grid should be used. It is wrong to use a hard radiation for a roentgenogram if it can be made with a soft one in the hope that the Potter-Bucky will make up for the loss due to the hard rays. This procedure decreases the contrast value of the roentgenogram. Therefore a soft ray technique such as was advocated some time ago by Chantraine is advisable. The so-called super-films the author tested were better than the old type. The blue color of the film is of no consequence.—*E. T. Leddy*.

CHANTRAINE, H. Wann ist eine Empfindlichkeitssteigerung des Films ein Fortschritt? (When is the increase of sensitivity of film an actual step forward?) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1934, *50*, 376–383.

Sensitivity of film is only one of its properties; gradation is just as important a characteristic. In the case of a new film with unknown changes in its gradation an increase of its sensitivity proves nothing. If, with an increase of sensitivity there is a decrease of gradation then this loss cannot be balanced by increased sensitivity if it is designed only to decrease the time of exposure. This loss of gradation can be compensated for only by a correctly decreased voltage during exposure. Some preliminary figures are presented by the author to show how many per cent of gradation loss are equal to 100 per cent increase in sensitivity so that in spite of an increase of 100 per cent in sensitivity there is no improvement in the film. A slight loss of gradation can be compensated for only by a great increase in sensitivity; the increase in sensitivity must be 7–10 times greater than the loss of gradation and only an increase greater than that can be regarded as any definite advantage.—*E. T. Leddy*.

LITWER, H. On the determination of the filter-working of filters for scattered rays, and of the elimination of scattered rays by other methods. *Acta radiol.*, 1935, *16*, 74–76.

The author discusses the value of Lysholm's filter in dissipating the fog caused by scattered rays. The Lysholm filter has two disadvantages: in the first place it causes fine lines on the film lines on the film that may be disturbing and in the second place if it is not treated with the utmost care slight cracks occur causing varying absorption of primary rays by different parts. The Lysholm filter is less effective than Victor's Potter-Bucky diaphragm. Two Lysholm filters placed crosswise, however, give a better result than the Victor. Two crossed Lysholm filters may be used, a Victor Potter-Bucky diaphragm, a small cone or a combination of these methods. —*Audrey G. Morgan*.

GALLAVRESI, LUIGI. Dispositivi stablizzatori, integratori ed automatici per la radiografia. (Integrating and automatic stabilizing apparatus for roentgenography.) *Radiol med.*, Dec., 1934, *21*, 1385–1413.

Various forms of stabilizing arrangements are illustrated and described in detail. There

are three types of these. The first guarantees the constancy of the roentgen illumination by stabilizing the current passing to the tube. The second cuts off the exposure automatically as soon as the tube has emitted a certain amount of irradiation. The third supplies ionometric control of the amount of radiant energy which falls on the plate. Theoretically the latter are the most effective, but as no form of apparatus dispenses with the necessity for correction on the part of the roentgenologist it would seem preferable at present to renounce the ionometric apparatus which complicate the roentgen installation and use only those forms of stabilizing apparatus which do away with undesirable variations in the tension of the current.—*Audrey G. Morgan.*

Bozzetti, Giuseppe. La realizzazione pratica della stratigrafia. (The practical accomplishment of stratigraphy.) *Radiol. med.*, March, 1935, *22*, 257–267.

In 1930, Vallebona described a new method of roentgenography which he called dissociation of the shadow and which the author calls stratigraphy. The object of it was to give a clear image of the special part to be examined while eliminating superimposed parts. The author describes and criticizes Vallebona's technique for accomplishing this and describes and illustrates the apparatus which he himself has devised for the purpose. He also gives roentgenograms of the skull taken by this method illustrating what can be accomplished by it.—*Audrey G. Morgan.*

Frik, K., and Ott, Paul. Was vermögen röntgenologische Körperschichtbilder gegenwärtig zu leisten? (The present status of planigraphy.) *Fortchr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 423.

The authors compare the advantages and disadvantages of this method. They used artificial defects in the distal and of the femur to demonstrate the importance of planigraphy in the present roentgen technique of examination. The authors conclude that the practical application of this method is very limited. Only rarely does it give diagnostic information any more important than that obtained by ordinary methods.—*E. T. Leddy.*

Bouwers, A. Über modern Aufnahmetechnik. (Modern roentgenographic technique.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 588–597.

The application of recently gained knowledge to the technique of roentgenography has resulted in better films. The rotating anode produces optimum conditions as the load may be increased on the target with a decrease in the size of the focal spot and is approximately inversely proportional to the width of the focal spot. Maximum sharpness of lung detail is obtained when $U_g = \frac{1}{4} U_b$ where U_g is geometrical unsharpness and U_b is unsharpness of the most rapidly moving part. The rotating anode permits a technique at a shorter distance and at a higher voltage than the stationary anode. The optimum load with a rotating anode for a roentgenogram of the chest is at the highest 20 kw. Greater loads result in loss of definition. Increasing the specific load of the rotating anode—insofar as practicable—results in better quality than was possible before the introduction of the rotating anode. Omission of screens can never result in increased efficiency or increased sensitivity of screens and films but always produces a decrease. Bouwers explains the new technique of "automatization," the principle of the energy supply for extremely short loads and specialization of apparatus. He describes a new machine incorporating these ideas and which weighs less than 4 kilograms.—*E. T. Leddy.*

Farberow, B. I. Ein einfaches und rasches Verfahren, Metallsplitter im Auge zu lokalisieren. (A simple and rapid method for localizing metalic splinters in the eye.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 578–586.

In the author's method the roentgenograms are all made on one 13×18 cm. film at 1 meter distance. One-half the film shows the position of the splinter with reference to the midline (the head is prone in the occipito-mental position) and the other half shows three shadows due to the fact that the line of vision is moved forward upward and downward if the splinter is in the eye. One shadow is seen when it is very small or in the rotation center or transverse axis of the eye. In the wet film the position of the splinter may be recognized; in the dry film its distances from the center may be determined. If it is necessary to find the exact distance from the surface of the globe opaque media may be injected into Tenon's space. Farberow shows three roentgenograms exemplifying the value of the method.—*E. T. Leddy.*

THALLER, R. Wodurch unterscheiden sich "Kestralröhren" von den bisher bekannten Röntgenröhren? (The differences between the "Kestral" tube and other roentgen tubes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 500–506.

In the Kestral tube the target is made of a cone of tungsten of such a design that it emits a great quantity of roentgen rays in a short time. By it all astigmatism is eliminated from the roentgenogram, great sharpness of detail is preserved. Exposures may be made at a flash at a great distance. The life of the conical target is unlimited because the surface of the cone does not pit or distort even at 3,000 Celsius and so there is no injury of the focal spot.—*E. T. Leddy.*

THALLER, R. Über die grundsätzliche Verschiedenheit des Belastungsvorganges bei Kestralröhren und bei Röhren der bisher gebräuchlichen Bauarten. (The fundamental differences between the loading of Kestral tubes and those of usual construction.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 507–509.

By using the elementary theories of heat and avoiding complicated mathematics, Thaller explains the phenomena of loading the Kestral tube. He points out that it is preferable to use a tube with a conical target to make the instantaneous exposures now so generally preferred in roentgenography.—*E. T. Leddy.*

AZKOVSKY, J., and JURIS, K. Versuch einer zahlenmässigen Erfassung der Kontraste im Röntgenbild. (The mathematical concept of contrast in the roentgenogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 509–516.

The authors show that contrast varies: (*a*) proportional to the gradation value of the curve of blackening of the film depending on the exposure; (*b*) proportional to the cube root of the fraction time of development employed divided by the time for full development (this formula holds for underdevelopment, with overdevelopment the contrast is constant); (*c*) indirectly proportional to a constant decrease of tube voltage; (*d*) proportional to the primary component of the total radiation which equals 1 minus the scattered ray component and which varies at each point in the film. The scattered ray component for the darkest point of the object (the most transparent part of the object) for some of the commonest types of roentgenograms is given.—*E. T. Leddy.*

WALTER, B. Über einige besonders krasse Fälle der Machschen optischen Täuschung. (A peculiarly well-marked case of Mach's optical illusion.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1934, *50*, 161–170.

The Mach optical illusion may take place with ordinary medical roentgen films and may lead to errors of diagnosis. The author, to bring this fact to the attention of roentgenologists, illustrates two especially instructive cases of this effect where an observer unless on the lookout for it could easily fall into error from a defect of the normal human eye.—*E. T. Leddy.*

BAYER, L. Röntgenologische Beiträge zur Physiologie und Pathologie des Magendarmkanals. (Roentgenologic contributions to our knowledge of the physiology and pathology of the gastrointestinal tract.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1934, *49*, 547–566.

As the result of his investigations Bayer shows (1) that there is no upper closing mechanism (in the sense of a sphincter) of the stomach. Such a closing mechanism is unnecessary because the diaphragm during respiration shuts off the esophagus at regular intervals so that precipitous filling of the stomach is prevented and a rhythmic filling takes place. (2) The "cardiac lip" acts as a functional exponent of the fornix in the sense of a valve acting in the retrograde direction. In this relationship the normal gas bubble in the fornix has an important place just as the diaphragm has in normal filling expansion and shape of the stomach. It is unnecessary and confusing to look for any nervous mechanism controlling each phase of the reception, ingestion and transport of food, which is a complex—not complicated—procedure the separate steps of which occur in regular sequence. (3) The increase in size of the gas in the stomach may have a regulatory importance. The increase in size of the gas bubble in gastric ulcer is a protective mechanism. (4) There is a form of aerophagia in which the air does not reach the stomach in separate small portions, but continually. The author discusses this reverse relationship as an example of reflex disturbance and in this connection he discusses briefly the pressure relationships in the abdomen.—*E. T. Leddy.*